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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS
SECTION B, ELECTRICAL ENGINEERING

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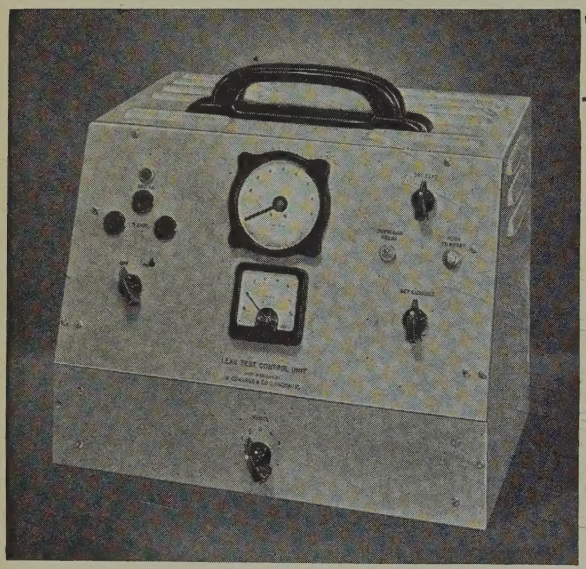
VOLUME 55 **JULY 1952** NUMBER 655

A New Solution to an Old Problem



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Principal Contents

JULY 1952

		PAGE
51	MATHEMATICS	585
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	585
53	PHYSICS	591
530.1	Fundamentals	591
531	General mechanics. Mechanics of solids	594
531.7	Mechanical measurements	595
532	Mechanics of fluids	595
532.6	Capillarity	596
532.7	Molecular theory of liquids	597
533	Mechanics of gases	599
533.7	Molecular theory of gases	599
534	Vibrations. Acoustics	599
535	Optics. Radiation. Spectra	603
536	Heat	612
536.7/.8	Thermodynamics	614
537	Electricity	615
537.1	Theory. Electrons	615
537.2	Electrostatics. Dielectrics	615
537.3	Electric conduction. Currents	616
537.52	Electric discharges	619
537.531	X-rays	621
537.533/.534	Cathode rays. Positive rays	622
537.54	Discharge tubes. Counters	623
537.56/.58	Ionization. Thermionics	625
537.591	Cosmic rays	625
538	Magnetism	626
538.3/.5	Electromagnetism. Electrodynamics	627
538.56	Electromagnetic waves and oscillators	627
538.6	Magnetic effects	628
539.1	Molecular and atomic structure	629
539.11	Theory of solid state	629
539.13	Molecular structure	630
539.15	Atomic structure. Nucleus. Isotopes	634
539.16	Radioactivity, α-, β- and γ-rays	636
539.17	Nuclear reactions	639
539.18	Atom and molecular beams. Mesons. Neutrons	641
539.2	Structure of solids	644
539.3/.8	Elasticity. Strength. Rheology	645
541	PHYSICAL CHEMISTRY	646
541.11/.12	Phase equilibrium. Chemical reactions	646
541.13	Electrochemistry	649
541.14/.15	Photochemistry. Radiation chemistry	649
541.18	Dispersions. Colloids. Adsorption	652
541.2/.6	Chemical structure	652
542.1/.7	Laboratory apparatus	—
542.9	Chemical processes	—
543/545	Chemical analysis	653
548	CRYSTALLOGRAPHY	654
548.7	Molecular and X-ray crystallography	655
55	GEOPHYSICS	658
551.5	Atmosphere. Meteorology	658
57/59	BIOLOGY	660
61	Medical science. Human physiology	—
66/67	TECHNICAL MATERIALS	—
77	PHOTOGRAPHY	—

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list, together with the lists published in the preceding issues of the current volume, supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplements published with the Indexes to Volume 53 (1950) and Volume 54 (1951). Reprints of the List of Journals (1950) and the Supplements (1950, 1951) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Akad. Wiss. Mainz Abh. Math.-nat. Kl.*	*Akademie der Wissenschaften und der Literatur* [*Mainz*]. *Abhandlungen der Mathematischnaturwissenschaftlichen Klasse.* [Abstracted by *Mathematical Reviews.*]
**Arch. Meteorol. Geophys. Bioklimatol. B*	*Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie B: Allgemeine und biologische Klimatologie.* Springer-Verlag, Vienna.
**Biul. Głów. Inst. Elektrotech.*	*Biuletyn Głównego Instytuto Elektrotechniki.* [Published as inset in *Przeglad Elektrotechnicky.*] Al Czackiego 3/5, Warsaw.
**Colliery Engng*	*Colliery Engineering.* [Abstracted by Metropolitan-Vickers Electrical Co.
**Heat. Vent. Engr*	*Heating and Ventilating Engineer.* [Abstracted by Metropolitan-Vickers Electrical Co.]
**Proc. New Zealand Instn Engrs*	*Proceedings of the New Zealand Institution of Engineers.* 8–12, The Terrace, Wellington, C.1.
Radio Commun.	*Radio Communication* (*FM-TV, The Journal of*). The Publishing House, Great Barrington, Massachusetts. [Now incorporating *Television Engineering.*]

Notes

DISSERTATION ABSTRACTS	Formerly known as MICROFILM ABSTRACTS. University Microfilms, 313 North First Street, Ann Arbor, Michigan.
FM-TV	See under *Radio Communication.*
MICROFILM ABSTRACTS	Title changed to DISSERTATION ABSTRACTS from issue dated Volume 12, No. 1, 1952.
Televis. Engng [*TVE*]	*Television Engineering.* Incorporated in *Radio Communication* from issue of May, 1952.

Errata

Author Index (1951), p. 1250, column 2, MENDELEV, B. G. *Insert* "Deionization of Hg vapours at low pressures in a strong electric field, 6289."

Abstr. 6563 (1950), line 2: *for* D. L. HOLLOWAY *read* D. L. HOLLWAY.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose Abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 6248 (1951): **21,** 712 (1951).

Abstr. 1982 (1952): **23,** 599–600 (*May,* 1952).

Abstr. 4291 (1952): **23,** 600 (*May,* 1952).

MATHEMATICS 51

518.1

4851. Non-iterative numerical solution of boundary-value problems. M. A. HYMAN. *Appl. Sci. Res. B*, **2**, 325–51 (*No.* 5, 1952).

518.2

4852. Table of factorization of the numbers $2N^2 + 1$. A. GLODEN. **Tables of Fresnel integrals, modified Fresnel integrals, the probability integral, and Dawson's integral.** M. S. CORRINGTON. **Tables of $\int_0^a I_0(a)da$ and $\int_a^\infty K_0(a)da$.** C. MACK AND M. CASTLE. **Chebyshev polynomials: exact values.** J. C. P. MILLER, C. W. JONES, J. F. C. CONN AND R. C. PANKHURST. **Sines and cosines of the decimal circle.** *Nature* [*Lond.*] **169**, 526 (*March* 29, 1952).

These unpublished tables have been deposited with the Royal Society of London, and are available for inspection and photocopying.

518.5 : 621–52 : 621.318.572

4853. Synthesis of electronic computing and control circuits. [STAFF OF THE COMPUTATION LABORATORY] *Annals of the Computation Laboratory of Harvard University, Volume XXVII. Cambridge, Mass., Harvard University Press; London, Geoffrey Cumberlege* (1951) 278 *pp.*

The book investigates the functional behaviour of electronic control circuits and develops an algebraic analysis based on a binary function of binary variables —the switching function. The mathematical methods with which the book is concerned cover procedures for (*a*) transforming functions from canonical form to those having a minimum number of variable occurrences, and (*b*) converting minimal forms into valve operators. Essentially, the design process consists of the sequence: mathematical expression of the problem, switching function expression, valve-operator expression, symbolic circuit, schematic and hence final circuit. The elaboration of symbolic circuits, the derivation of their describing expressions, and the formal rules of manipulation are initially treated in consideration of the 2- and 3-variable problem, and thence that of n variables. A chart for the derivation of minimal forms for functions of 3 variables is given, with rules, and discussed in relation to symbolic circuits which are classified in regard to the means by which their output voltage is delivered. Minimizing charts are quoted. Pyramid and rectangle multiple-output circuits are specially treated, which lead to the general multiple-output case. Problems peculiar to trigger circuit analysis are indicated and those circuits adapted to the general treatment are defined. Ring and digit counters are thus analysed, and 5-variable charts drawn up to provide the required minimal expressions. The introduction of time variables does not affect the general mathematical procedure which is well suited for circuits involving, e.g., gating voltages or advancing pulses. The technique is developed to handle the operation of units of electronic digital computers: rectifiers, coders (the minimal circuit is here derived for a given coding system), adders and accumulators, multipliers. Examples of design problems, mainly computing, are worked out in all sections to demonstrate the methods and their field of application. The selection of these examples and the symbolic circuits associated with them are representative and excellently presented. Tables of input inversions, input rearrangements and switching functions, all for 4 variables, are appended and their use explained.

A. J. KENNEDY (R)

519.1

4854. On the use of a random parameter in combinatorial problems. C. DOMB. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 305–9 (*May*, 1952).

Many problems in probability connected with n events occurring randomly in space can be substantially simplified by dealing first with an indefinite number of events distributed in a Poisson series. A combinatorial problem arising in cosmic-ray counting discussed recently by Schrödinger provides a good example, and several properties of the corresponding distribution are derived. A generalization of this problem is considered, and the method is also applied to the random division of a line. A.

519.21 : 533.7

4855. A linear random walk with a partly reflecting partly absorbing barrier. H. A. LAUWERIER. *Appl. Sci. Res. B*, **2**, 294–300 (*No.* 4, 1952).

A generalization is given of the simple linear random walk which includes the well-known restricted R. W. with either an absorbing or a reflecting boundary. Introducing a probability p of being absorbed and $1 - p$ of being reflected at the boundary it can be shown that this more complicated problem can be considered as a linear combination of the simpler cases $p = 0$ and $p = 1$. This can be found from the asymptotic representation of its solution. Debye's saddle point method is used. The results can be interpreted in the theory of diffusion of matter. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.13

4856. Stability investigations in the restricted four-body problem. P. PEDERSEN. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **26**, 37 *pp.* (*No.* 16, 1952) *In German.*

The motion is investigated of a particle of vanishingly small mass in the gravitational field of three massive particles which form the vertices of an equilateral triangle, the motion being in the plane of this triangle. Stability conditions at libration points are discussed. R. A. NEWING

522.2

4857. The tower-telescope of Göttingen Observatory. P. TEN BRUGGENCATE AND F. W. JÄGER. *Nachr. Wiss. Göttingen, Math.-phys. Kl. IIa, No.* 5, 26 *pp.* (1951) *In German.*

Technical descriptions of the instrument, and ancillary equipment brought into use in 1944. 22 illustrations. D. R. BARBER

523.11

4858. The evolution of a gaseous mass rotating about a central body. I. Solution of hydrodynamical equations with turbulent friction. R. LÜST. *Z. Naturforsch.*, **7a,** 87–98 (*Jan.*, 1952) *In German.*

Some qualitative considerations in Weizsäcker's theory of planetary formation are confirmed by obtaining approximate solutions of the equations. It is assumed that radial velocities are very small, and that the gravitational field due to the gaseous mass may be neglected. Solutions obtained for 2- and for 3-dimensional models are of two types: (i) the angular momentum of the central body is conserved and part of the gaseous mass falls onto the body, the rest escaping from the system, (ii) the gaseous mass gains angular momentum from the body, and escapes completely from the system.

R. A. NEWING

523.11

4859. On the evolution of a rotating gaseous mass. E. TREFFTZ. *Z. Naturforsch.*, **7a,** 99–103 (*Jan.*, 1952) *In German.*

The investigation is based on Weizsäcker's theory of the evolution of a gaseous mass under the action of its own gravitational field. The initial density of the two-dimensional model considered is assumed to be $\propto (1 + s^2)^{-2}$, where s is distance from the axis of rotation. Numerical integrations confirm the formation of a uniform central mass of finite extent which rotates with constant angular velocity; the outer parts of the gas escape from the system. R. A. NEWING

523.112

4860. On the expansion of the universe. I. F. ZAGAR. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **12,** 12–16 (*Jan.*, 1952) *In Italian.*

A criticism of the interpretation of red-shifts as expansion is based on Newtonian mechanics.

R. A. NEWING

523.112

4861. The role of turbulence in the evolution of the universe. G. GAMOW. Letter in *Phys. Rev.*, **86,** 251 (*April* 15, 1952).

The condensation of protogalaxies would require large-scale density fluctuations such as could be provided by turbulent motion. Difficulties concerning the origin of such motion in uniformly expanding material suggest the postulate of primordial turbulence. R. A. NEWING

523.16 : 621.317.34 : 621.317.789.029.6

4862. The design of an equipment for measuring small radio-frequency noise powers. K. E. MACHIN, M. RYLE AND D. D. VONBERG. *Proc. Instn Elect. Engrs, Pt III,* **99,** 127–34 (*May*, 1952).

Discusses the design of an equipment for the continuous recording of the very small r.f. noise powers received from the sun and the galaxy. It is first shown how a noise power can be described in terms of an equivalent temperature, and how cable attenuation affects the noise power measured at the end of an aerial feeder. The fundamentals of the measurement of noise power are considered; it is shown that the minimum detectable power is determined by the receiver noise and by the ratio of input and output bandwidths of the receiver. The practical difficulties inherent in the measurement have been overcome by the design of a self-balancing equipment in which a locally generated noise power is continuously adjusted to equality with the incoming power. A description of such an equipment is given; the design of the r.f. switch, the local noise source, the receiver and the control circuits for the noise source are considered in some detail. The performance of the equipment is analysed in terms of its accuracy, its response to a step function of input and the fluctuations of its output indication. Experimental determinations of the performance compare reasonably well with theory. A.

523.161

4863. Irregularities in the galactic absorbing layer. B. J. BOK. *Bull. Harvard Coll. Obs., No.* 920, 1–5 (*Sept.*, 1951).

Observational evidence for the hypothesis that interstellar matter occurs mainly in small clouds is reviewed and it is suggested that the distribution of dark matter may be less patchy than is commonly supposed. The importance is emphasized of studies on the association of positive and negative residuals in nebular and stellar counts. R. A. NEWING

523.161

4864. The distribution of interstellar sodium. II. L. SPITZER, JR AND J. B. OKE. *Astrophys. J.*, **115,** 222–6 (*March*, 1952).

For Pt I, see Abstr. 1647 (1949). Van Rhijn found no correlation between the equivalent widths of interstellar Na and Ca lines and either colour excess or distance from the nulls of galactic rotation. His analysis is repeated here for the Na D lines alone, in an attempt to reconcile his result with previous differing conclusions by Spitzer. The results indicate that a variation of the equivalent widths with galactic longitude, of the sort expected from the radial velocities due to galactic rotation, is present, in agreement with theory. However, the apparent correlation previously found between the equivalent width D and the colour excess E_1 for stars with spectroscopic distances of about 1000 parsecs is shown to be due to errors in the distances; according to the mean distance found from stellar radial velocities and the galactic-rotation formula, the unreddened stars are much closer than assumed and have correspondingly weaker interstellar D lines. Whether a correlation between D and E_1 actually exists for stars at the same distance is difficult to tell from this analysis. That some correlation must be present follows from the previously observed and unmistakable correlation between the doublet ratio D_2/D_1 and E_1, which indicates that the larger fraction of the Na I atoms are found in the same clouds containing the obscuring grains. A.

523.161

4865. A comparison of the components in interstellar sodium and calcium. P. M. ROUTLY AND L. SPITZER, JR. *Astrophys. J.*, **115**, 227–43 (*March*, 1952).

Radial velocities and equivalent widths of the interstellar *D* lines, including a number of faint components, were obtained for some twenty stars from high-dispersion spectrograms taken at the Mount Wilson Observatory. Corresponding measures in Ca II were also obtained for 4 stars. This material, together with additional measures obtained previously by other investigators, was employed in a comparison between Na and Ca. For each component N(Na I) and N(Ca II), the numbers of absorbing Na I atoms and Ca II ions in the line of sight, were found whenever possible, as were also the values of the Doppler widths b(Na I) and b(Ca II). For strong components, the data indicate that b(Ca II) in km/sec is about 1·5 times b(Na I), in qualitative agreement with Wilson's analysis; but for weaker lines these Doppler widths are more nearly equal. On the average, a marked decrease occurs in N(Na I)/N(Ca II) as the residual radial velocity of the component increases in absolute value; in low-velocity clouds Na I tends to be more abundant than Ca II, while in high-velocity clouds the reverse is true. This result apparently explains why the strong saturated lines of Na I and Ca II do not lie on the same curve of growth [b(Ca II) > b(Na I)]. Consideration is given to the possibility that differences of ionization between high-velocity and low-velocity clouds may explain this variation of abundance ratio with cloud velocity. In a rapidly moving cloud the kinetic temperature should be increased, since the intercloud gas in front of the cloud will be compressed and heated. At a temperature somewhere between 5000° and 10 000°, collisional ionization of Na I by electrons would reduce the ratio N(Na I)/N(Ca II) by the observed factor. However, it is uncertain whether the temperature can be so high, and other mechanisms may be important. A.

523.161 : 523.6

4866. Gas hydrates in cometary nuclei and interstellar grains. A. H. DELSEMME AND P. SWINGS. *Ann. Astrophys.*, **15**, 1–6 (*Jan.–March*, 1952) *In French.*

Solid hydrates of CH_4, CO_2, . . . may be present in cometary nuclei and interstellar grains. The vapour pressures—hence the rates of sublimation—of the various hydrates are of the same order of magnitude while the vapour pressures of solid CH_4, H_2O, . . . differ by very large factors. The relative abundances of the radicals which are observed in comets would be explained more satisfactorily by assuming the presence of solid hydrates. A.

523.165

4867. Observations of galactic radiation at frequencies of 1210 and 3000 Mc/s. J. H. PIDDINGTON AND H. C. MINNETT. *Aust. J. Sci. Res. A*, **4**, 459–75 (*Dec.*, 1951).

Measurements are described of galactic radiation at frequencies of 1210 and 3000 Mc/s. The results provide extensions of previous radio emission spectra by more than 2½ octaves. The intensity of radiation from near the galactic centre was measured, and an estimate made of the direction of the maximum of such radiation. A new "discrete source" of peculiar spectrum was discovered very close to the centre of the Galaxy. Evidence suggests that the power output of this and some other sources in the radio spectrum may exceed the total power output of the sun. Radiation was also observed from the direction of the Crab Nebula, from the known "radio source" in Centaurus, and from the moon. Two nebulae (M 31 and NGC 7293) were investigated with negative results. The spectra of two sources are given between the limits 18·3 and 1200 Mc/s. A.

523.165 : 523.77 : 523.87

4868. The radio-frequency line spectrum of atomic hydrogen and its applications in astronomy. J. P. WILD. *Astrophys. J.*, **115**, 206–21 (*March*, 1952).

Formulae are obtained for the frequencies, transition probabilities and natural widths of the discrete lines of atomic H that fall within the radio spectrum. Such lines are due to transitions within either the fine structure or the hyperfine structure of the energy levels. The conditions necessary for the formation of observable emission and absorption lines are examined. Thence an inquiry is made into which of the H lines are likely to be observable from astronomical systems. It is found that the sun may give a detectable absorption line at about 10 000 Mc/s, corresponding to the $2^2S_{1/2} - 2^2P_{3/2}$ fine-structure transition, but that other solar lines are not likely to be observable. From the interstellar gas, the emission line already observed (i.e. the 1420 Mc/s hyperfine-structure line) is probably the only detectable H line. The importance of this line in the study of the interstellar gas is discussed. Some general conclusions are drawn from the preliminary evidence regarding the motion and kinetic temperature of the regions of un-ionized H. The ratio data are used to obtain a measure of the product of "galactic thickness" and average H concentration. A.

523.165 : 523.854.22

4869. Galactic radiation at radio frequencies. IV. The distribution of radio stars in the galaxy. J. G. BOLTON AND K. C. WESTFOLD. *Aust. J. Sci. Res. A*, **4**, 476–88 (*Dec.*, 1951).

The distribution of sources of galactic noise at 100 Mc/s in the galactic plane is deduced from the data of a previous survey [Abstr. 796–8 (1950)], assuming axial symmetry. Effects of absorption and emission within the interstellar gas are considered and found to be negligible. Away from the galactic plane, the noise contours do not conform to a single spheroidal source distribution. Consideration is given to an isotropic contribution to the general background radiation—possibly extragalactic in origin. On the hypothesis that the background radiation is the aggregate emission from a distribution of radio stars typified by the discrete sources previously studied, estimates of the local number density, the flux from a typical radio star, and the distances of some of the observed discrete sources are made. These estimates are briefly discussed. A.

523.26

4870. Stability of astronomical systems. D. D. IVANENKO, A. M. BRODSKIĬ AND L. P. GINZBURG. *Dokl. Akad. Nauk SSSR*, **80**, 565–7 (*No.* 4, 1951) *In Russian.*

It is argued that the determination of stability in

certain astronomical systems can be arrived at through the consideration of the temperature of a weak gravitational field included in any such system. Formulae are given for the calculation of the density of energy of such heat radiation, which is found to correspond with the limit of the system. Since the density of energy of a gravitational field is fixed by the degree of curvature of space at a given point, it appears that the stability of a system can be estimated by the relations there subsisting between radius, temperature and mass. A table is appended of critical temperatures found to be related to masses and radii of the solar and certain planetary systems.

J. CLEUGH

523.4

4871. Retarding effect of wave and corpuscular radiation, due to alteration of solar mass. V. V. RADZIEVSKIĬ. *Dokl. Akad. Nauk SSSR*, **81**, 167–70 (*No.* 2, 1951) *In Russian.*

The retarding phenomenon of the increase of the radius of the heliocentric orbit of a body, as a result of solar radiation and consequent diminution of solar mass, is investigated in the case of a body which fully absorbs both types of solar radiation. The formulae worked out in the calculation of such radiation are found to be adverse to the hypothesis of the formation of planets by separation from the sun. J. CLEUGH

523.72

4872. Ejection of hydrogen atoms from the sun. E. R. MUSTEL. *Dokl. Akad. Nauk SSSR*, **81**, 363–6 (*No.* 3, 1951) *In Russian.*

It was shown by the author in 1948 that light pressure on hydrogen atoms in the active solar regions was insufficient for the direct expulsion of such atoms from the sun. The fact, however, of the presence of hydrogen in solar corpuscular flow is now proved. The article, therefore, goes on to a further consideration of the cause of the phenomenon. The conclusion is reached that the chromospheric flash is in some way responsible, in connection with geomagnetic disturbances. J. CLEUGH

523.72

4873. The position and movement on the solar disk of sources of radiation at a frequency of 97 Mc/s. I. Equipment. A. G. LITTLE AND R. PAYNE-SCOTT. *Aust. J. Sci. Res. A*, **4**, 489–507 (*Dec.*, 1951).

The spaced-aerial interference technique, as used in radio astronomy, has been modified in order to observe solar disturbances which are either of short duration or are rapidly changing in position. The interference pattern is obtained in 1/25 of a second by sweeping the aerial lobe pattern across the source, 25 times per second. The position of the source and the polarization of the radiation are determined separately, a complete record taking about one second. Two different aerial spacings are used and calibration is carried out by a novel method. An equipment operating on 97 Mc/s, which has been used for observations of solar disturbances, is described and the sources of error discussed. A.

523.72

4874. The position and movement on the solar disk of sources of radiation at a frequency of 97 Mc/s. II. Noise storms. R. PAYNE-SCOTT AND A. G. LITTLE. *Aust. J. Sci. Res. A*, **4**, 508–25 (*Dec.*, 1951).

Using the equipment described in Pt I, the apparent position and polarization of the sources of solar radiation at 97 Mc/s have been measured at some time during about 30 noise storms occurring between May 1949 and July 1950, and the progress of the source during about six of these has been observed in some detail. The best criterion available for the chance of a storm occurring is shown to be the size of the largest visible individual sunspot. The evidence suggests that the storm radiation is associated with this spot only and not with the rest of the group, that the spot magnetic field is the important factor, and that the direction of rotation of the circular polarization of the storm radiation depends on the magnetic polarity of the associated spot, being usually left-handed when the largest spot is a north-seeking pole and right-handed when it is a south pole. Deviations observed between the apparent positions of radio source and visible sunspot on the solar disk are explained in terms of a high origin of the storm radiation in the solar corona, the observed heights varying from 0·3 to 1·0 photospheric radii above the Sun's visible surface. A.

523.72

4875. The position and movement on the solar disk of sources of radiation at a frequency of 97 Mc/s. III. Outbursts. R. PAYNE-SCOTT AND A. G. LITTLE. *Aust. J. Sci. Res. A*, **5**, 32–46 (*March*, 1952).

The apparent position and polarization of the source of solar radiation at 97 Mc/s have been measured during six outbursts, for five of which data on the accompanying solar flares are available. Initially the apparent position of outburst and flare almost coincide, the outbursts usually being rather closer to the solar limb than the flare. As the outburst proceeds, its position rapidly changes, the apparent movement usually being towards, and sometimes off, the solar limb. The initial apparent displacement towards the solar limb and the subsequent movement can be explained if we assume that the outburst radiation is excited by some physical agency originating at the same time, and in the same region, as the flare, and moving outward through the corona. The velocity of such an agency would need to be between 500 and 3000 km/sec, and it is suggested that the corpuscular streams associated with sudden-commencement terrestrial magnetic storms are the initiators of outbursts. The polarization of the outbursts in the early stages is random. Often a second increase occurs, with elliptical, usually circular, polarization. On two occasions linear polarization has been observed in this later stage of an outburst. The relation between the changes in polarization and the associated changes in apparent position conform to the rule given in Pt II, that right-hand circular polarization arises in the region above a south magnetic pole and left-hand above a north pole, while linear polarization appears to originate above the central region of a bipolar group, the *E*-vector having a direction approximately along the axis of the spot-group. A.

523.73

4876. The state of rotation of the sun. S. TEMESVÁRY. *Z. Naturforsch.*, **7a**, 103–20 (*Jan.*, 1952) *In German.*

A hydrodynamical discussion of circulation currents at different levels of the solar atmosphere in relation to the formation and maintenance of sunspot zones.

D. R. BARBER

523.75

4877. A solar flare and associated dark flocculi of May 19, 1951. H. W. DODSON. *Astrophys. J.*, **115**, 320–2 (*March*, 1952).

The dark absorbing material that accompanied the flare of May 19, 1951, 19^h57^m, extended at least 125 000 km from the apparent region of ejection and displayed radial velocities that ranged from −182 to +225 km/sec. The motions indicated are consistent with the interpretation of the dark flocculus as a giant surge seen in projection on the disk. This absorbing material modified the form and intensity of the giant surge seen in projection on the disk. This absorbing material modified the form and intensity of the associated flare. A.

523.75

4878. On some analogous effects of light absorption in prominences and discharges. Y. ÖHMAN. *Ark. Astron.*, **1**, 309–14 (*Paper* 26, 1952).

Experiments with high-tension ($\simeq 10^5$ V) air discharges are described which simulate absorption phenomena viewed against bright H α prominences observed outside the solar limb. Estimated effective temperatures of bright, and dark areas are *c.* 4000°K, and *c.* 2000°K respectively. D. R. BARBER

523.755

4879. Possible identification of a solar *M*-region with a coronal region of intense radio emission. A. MAXWELL. *Observatory*, **72**, 22–6 (*Feb.*, 1952).

Enhanced noise on the metre waveband associated with the visually inactive sunspot group of C.M.P. 1950 June 14·5 was found to have a 27-day recurrence tendency for the ensuing 6 months. Since these wavelengths arise in the corona, a coronal nature of the *M*-regions is suggested. M. W. OVENDEN

523.77

4880. The interpretation of the observed hydrogen lines in the infrared solar spectrum. I–II. C. DE JAGER AND L. NEVEN. *Proc. K. Ned. Acad. Wet. B*, **55**, 153–73 (*No.* 2, 1952).

Calculations of the profiles of the Paschen and the Brackett lines in the infrared solar spectrum are made on the basis of statistical widening by the Stark effect of the surrounding ions. Comparison of the observations with the calculations shows that the calculated profiles are much narrower than the observed; the differences being greatest for the Brackett lines. (Factors 2·3 and 3·1 respectively.) The assumption that the electrons contribute also to the statistical Stark widening cannot explain the discrepancy. It is shown that there is no clear indication of the existence of superexcitation, which phenomenon was suggested earlier to explain the great strength of the Brackett lines as compared with the Paschen and Balmer lines. A.

523.77

4881. The continuous emission spectrum of the solar corona in the far u.v. and the adjacent X-radiation. G. ELWERT. *Z. Naturforsch.*, **7a**, 202–4 (*Feb.*, 1952) *In German.*

523.77

4882. Hyperfine structure in the solar spectrum. A. ABT. *Astrophys. J.*, **115**, 199–205 (*March*, 1952).

The hyperfine structure of certain lines can be detected in the solar spectrum as reproduced in the Utrecht atlas; it can contribute appreciably to the width of the lines. The agreement between the predicted and observed half-widths and profiles of lines with hyperfine structure broadening is good. Solar lines with wide hyperfine structure patterns show a wavelength shift towards the weak end of the pattern as compared to the laboratory wavelength. Hyperfine broadened lines fall on a different curve of growth, characterized by a larger Doppler velocity and a smaller damping constant. A résumé of the elements most affected by hyperfine broadening is given. A.

523.841

4883. On the distribution of long-period variables implied by the period-luminosity relation. D. HOFFLEIT. *Bull. Harv. Coll. Obs.*, *No.* 920, 18–22 (*Sept.*, 1951).

Estimates of distance, uncorrected for space absorption, for 3000 long-period variable stars with periods > 140 d and < 470 d, derived from the period-luminosity relationship of Wilson and Merrill (1942), are discussed. An extreme upper limit of 8 kpc is indicated for the thickness of the system of l.-p. variable stars between sun and galactic centre. D. R. BARBER

523.842

4884. The effective temperatures of components of eclipsing binary systems. Z. KOPAL AND C. G. TREUENFELS. *Circ. Harvard Coll. Obs.*, *No.* 457, 26 *pp.* (1951).

The parallactic and peculiar components of proper motions and radial velocities are used to deduce the mean absolute magnitudes of 227 components of eclipsing binary systems, divided in 8 groups according to their spectra. By a combination of such absolute magnitudes with the mean absolute radii of stars within each group, the mean effective temperatures of such stars have been derived. It is concluded from the results that Kuiper's effective temperatures of the O and early B stars, based almost exclusively on indirect observational evidence, overestimate the actual flux of energy through the photospheres of such stars by a fairly wide margin, and that the revised effective temperatures following from the present investigation are likely to be much nearer to their actual values. A.

523.842

4885. An interpretation of the photometric observations of Zeta Aurigae. F. E. ROACH AND F. B. WOOD. *Ann. Astrophys.*, **15**, 21–53 (*Jan.–March*, 1952).

The photoelectric observations of Zeta Aurigae made during the eclipses of 1939–40 and 1947–48 are critically discussed. Evidence is given which indicates that the partial phases of the eclipse are due to the gradual extinction of the light of the B-star

by the atmosphere of the K-star. The probable mechanism of extinction is shown to be the weakening of the light of the B-star by absorption lines which result from the transit of the light through the K-star's atmosphere. The fact that the eclipse starts earlier in the ultraviolet than in the blue rules out continuous absorption by the negative hydrogen ion as a major source of extinction from which it is deduced that the temperature of the K-star's atmosphere, effective in the excitation of hydrogen, is greater than about 5000°K. A comparative study of the two eclipses suggests that the diameter of the K-star was approximately 1% greater in 1939–40 than in 1947–48. A.

523.851.2

4886. The applicability of the virial theorem to evolving clusters. U. VAN WIJK. *Bull. Harv. Coll. Obs., No.* 920, 6–9 (*Sept.*, 1951).

A previous investigation [Abstr. 1423 (1950)] was based on the theorem in the form $2T + \Omega = 0$. Errors involved in neglecting the term $\frac{1}{2}d^2I/dt^2$ are discussed and found to be negligibly small. R. A. NEWING

523.852.3 : 522.615

4887. Six-color photometry of stars. VII. Light-curves of Eta Aquilae. J. STEBBINS, G. E. KRON AND J. L. SMITH. *Astrophys. J.*, **115,** 292–300 (*March*, 1952).

For Pt VI, see Abstr. 1661 (1949). Light-curves of the variable star η Aquilae have been obtained in six colours from the u.v. at 3530 Å to the infrared at 10 300 Å. The variations in all colours show the well-known hump in the light-curve about halfway down in the decreasing phase, with indications of other secondary fluctuations. The amplitudes of variation range from 1·45 mag. in the ultraviolet to 0·37 in the infrared. The times of maximum and minimum come progressively later in the longer wavelengths, the displacement of phase being 0·05 period between 3530 Å and 10 300 Å, the same retardation that was found in δ Cephei. The colours of η Aquilae at maximum nearly match those of supergiant stars of spectrum cF7; at minimum they approximate cG3; but the variable is not quite a typical star at either phase. The mean radius is found from the light- and colour-curves, combined with an integrated velocity-curve, to be $R = 4{\cdot}7 \times 10^7$ km $= 68R_\odot$, a value somewhat larger than previous determinations. The period of this variable is shown to be lengthening at the present time. A.

523.852.32

4888. The spiral nebula as a star-system. P. TEN BRUGGENCATE. *Naturwissenschaften,* **39,** 121–8 (*No.* 6, 1952) *In German.*

The substance of a public discourse delivered at a meeting of the Astronomical Society of Recklinghausen, 24 Aug., 1951. 8 illustrations. D. R. BARBER

523.872

4889. Three-colour photometry of L and χ Persei. W. BECKER. *Z. Astrophys.*, **30,** 164–76 (*No.* 3, 1952) *In German.*

523.877

4890. The *X*- and *Y*-functions for isotropic scattering. I. S. CHANDRASEKHAR, D. ELBERT AND A. FRANKLIN. *Astrophys. J.*, **115,** 244–68 (*March*, 1952).

X- and *Y*-functions which occur in the solution of transfer problems in atmospheres of finite optical thicknesses and scattering radiation isotropically with an albedo $\omega_0 \leqslant 1$ for single scattering are tabulated. The values of the albedo, ω_0, and optical thickness, τ, for which solutions are tabulated are: $\omega_0 = 1$, 0·95, 0·9, 0·8, 0·5 and $\tau = 0{\cdot}05$, 0·10, 0·15, 0·20, 0·25, 0·5 and 1. A.

523.877

4891. The *X*- and *Y*-functions for isotropic scattering. II. S. CHANDRASEKHAR AND D. ELBERT. *Astrophys. J.*, **115,** 269–78 (*March*, 1952).

The moments of order zero and one of the *X*- and *Y*-functions tabulated in the preceding paper are evaluated, and certain relations which these moments should satisfy are verified. In the conservative case ($\omega_0 = 1$) the standard solutions and the solutions appropriate to the problem of diffuse reflection and transmission are tabulated. Finally, a table is provided for calculating the exact values of the residual intensity on Schuster's model of line formation. A.

523.877

4892. Turbulent velocities in the atmospheres of red-giants. E. SCHATZMAN. *C.R. Acad. Sci.* [*Paris*] **234,** 1349–51 (*March* 24, 1952) *In French.*

Continuing earlier work [Abstr. 6725 (1949)] it is shown that constancy of ratio, mech. energy flux/total flux, for certain red-giant atmospheres, is due to the nature of the mech. forces responsible for the compression waves which arise in the deep, turbulent convective zones of these atmospheres. D. R. BARBER

523.877 : 523.852

4893. On the radiation pressure in a planetary nebula. I. W. UNNO. *Proc. Japan Acad.*, **26,** 17–22 (*June*, 1950).

The radiation pressure of the Lyman α-line-radiation in a planetary nebula is discussed. Zanstra's idea of redistribution in frequency in the line-contour is taken into account in detail. The equation of transfer of the Lyman α-radiation with redistribution mechanism is solved in contrast with Zanstra's rough treatment in which a definite form of emission and complete redistribution are assumed. The result obtained is found to be nearly the same as in Zanstra's theory. The radiation pressure due to the Lyman α-radiation is so much reduced that it should be possible to get rid of the blowing-up difficulty of planetary nebula in Ambarzumian's theory. Thus it is confirmed that the complete redistribution is a good approximation to the solution of this problem. A.

525.622

4894. Earth tides. *Observatory,* **72,** 16–21 (*Feb.*, 1952).

Report of proceedings at a geophysical meeting of the Royal Astronomical Society (London). Theoretical and practical aspects of seasonal tidal tilting, observed with horizontal pendulums, at Bidston and Winsford, Cheshire. At the latter station an annual variation, with maximum to the S in summer, is found. D. R. BARBER

PHYSICS 53

53.081

4895. On giving a distinct name to the fundamental unit of mass. G. POLVANI. *Nuovo Cim.*, **8,** 180–97 (*Suppl. No.* 2, 1952). [Also in *Ric. Sci.*, **22,** 597–614 (*Apr.*, 1952) *In Italian.*]

A discussion from the literary and historical standpoints of suitable Greek and Latin terms for the fundamental unit so as to distinguish it from the international Pt–Ir kilogramme. "Brize," "stathm" or "bes" with respective abbreviation "b," "st" or "b," is suggested. These are derived from "$\beta\rho\iota\theta o\varsigma$," "$\sigma\tau\alpha\theta\mu o\varsigma$" and "binae partes assis." S. WEINTROUB

FUNDAMENTALS 530.1

530.1

4896. New derivation and physical interpretation of Bogolyubov's equation for equilibrium distribution functions. I. Z. FISHER. *Zh. Eksper. Teor. Fiz.*, **21,** 1109–12 (*No.* 10, 1951) *In Russian.*

Mathematical. The new derivation does not make explicit reference to Gibbs's canonical distribution; rather this follows automatically, using mathematical induction, from the equations established here.

J. JACOBS

530.12

4897. Astronautics and relativity. C. MAUGUIN. *C.R. Acad. Sci.* [*Paris*] **234,** 1004–7 (*March* 3); 1329 (*March* 24, 1952) *In French.*

The relationship between the distance x (in light years) travelled by a hypothetical vehicle, in a system in which the vehicle is at rest at zero time and the time τ (in years) measured in the vehicle, is derived for the case in which the vehicle is moving with a constant acceleration of 950 cm sec^{-2} (measured with respect to a system instantaneously at rest relative to the vehicle at any instant). In this case $x = \cosh \tau - 1$, the corresponding time which elapses in the fixed system is $t = \sinh \tau$. L. R. SHEPHERD

530.12 : 531.18

4898. On the principle of the constancy of the velocity of light. K. D. STIEGLER. *C.R. Acad. Sci.* [*Paris*] **234,** 1250–2 (*March* 17, 1952) *In French.*

The constancy of c is deduced from a set of axioms that involve the assumption that the velocity of a frame of reference S' relative to $S = -1\times$ the velocity of S relative to S'. R. A. NEWING

530.12 : 531.314.3

4899. The special theory of relativity based upon Hamiltonian mechanics. W. MACKE. *Z. Naturforsch.*, **7a,** 76–8 (*Jan.*, 1952) *In German.*

Energy and time are represented as conjugate variables, and invariance with respect to canonical transformations leads to relativistic mechanics.

R. A. NEWING

530.13

4900. On the conservation laws of physics. P. JORDAN. *Z. Naturforsch.*, **7a,** 78–81 (*Jan.*, 1952) *In German.*

The conservation of energy-momentum and of electric charge are associated with invariance under 4-dimensional co-ordinate transformations and under gauge transformations; these two types of invariance are included in a single invariant group in 5-dimensional field theories. A 6-dimensional field theory would give rise to a new type of invariance, and thus to a new conservation law such as that suggested by E. Wigner for "neutron charge" [Abstr. 3747 (1950)].

R. A. NEWING

530.14

4901. The projective ennuple and the unification of the electromagnetic theories of Weyl and Veblen–Hoffmann. R. L. INGRAHAM. *Ann. Inst. Poincaré*, **12,** 131–58 (*No.* 3, 1951) *In French.*

Weyl's unified theory of gravitational, electromagnetic and electron spinor fields [*Z. Phys.*, **56,** 330 (1929)] was expressed in terms of orthogonal ennuples in affine space. It is shown that this theory may be restated as a projective field theory, the three-term Langrangian being replaced by an expression with two terms corresponding to gravitation plus electromagnetism and to the spinor field.

R. A. NEWING

530.145

4902. A theorem in correlation calculus, of significance for quantum mechanics. F. BOPP. *Z. Naturforsch.*, **7a,** 82–7 (*Jan.*, 1952) *In German.*

It is shown that a correlation probability $P(1, 2)$ may be split uniquely into two factors, which satisfy specified conditions. Hence, a representation of the average values in the usual correlation statistics is obtained, which agrees with the average value of the Gibbs ensemble of quantum-mechanical systems. The importance of this result for quantum mechanics is discussed. R. H. DALITZ

530.145

4903. Formal correspondence, order of factors and Poisson brackets. R. HAAG. Note in *Z. Naturforsch.*, **7a,** 207–8 (*Feb.*, 1952) *In German.*

Some remarks concerning the importance of the order of factors in the quantum-theory operator corresponding to a classical function of canonical variables and the interpretation of commutation relations. R. H. DALITZ

530.145

4904. An expansion theorem of the density matrix. R. KUBO. *J. Chem. Phys.*, **20,** 770–8 (*May*, 1952).

A general theorem is proved on the density matrix of quantum statistics. Some possible applications are briefly discussed. A.

530.145

4905. Some of the results of generalized field theory. V. I. RODICHEV. *Zh. Eksper. Teor. Fiz.*, **21,** 869–78 (*No.* 8, 1951) *In Russian.*

The generalized field is presented in a form of an antisymmetrical 5-tensor of 2-d rank, the components of which are formed, in the same way as the curl, from a dependent 5-vector (A_x, A_y, A_z, $i\phi$, A_0) and independent 5-vector (x, y, z, ict, s), where the first three components of each 5-vector form a 3-dimensional vector, A_0 is a pseudo-scalar, and s is also a

pseudo-scalar playing the part of a time in a system of co-ordinates with reference to which a given system is 4-dimensionally at rest. It is assumed that the tensor field has no "sources" and therefore it satisfies 5-dimensional continuity equations. Out of 10 components of this antisymmetrical tensor, having different absolute values, 6 are components of the electro-magnetic field, 3 are the components of a 3-dimensional vector interpreted as an integral of the "meson current density" with respect to s, and one component is a scalar interpreted as an integral of the "meson charge density" with respect to s. This structure of the tensor yields the equations of meson field, including the e.m. equations, in 3-dimensionally vectorial form, and also the 5-dimensional wave equation (which in addition to the Dalamberian operator includes the second derivative with respect to s) for each component. Two quantized particular solutions of these wave equations are discussed in some detail: plane waves and spherical waves. The former solution is obtained in the form of an exponential with a complex argument, while the latter solution is developed in terms of Hankel functions of the first kind, spherical harmonics, and Gegenbauer's polynoms. The expressions for the symmetrical energy-impulse tensor are then derived, from which formulae are drawn for the calculation of the forces arising from the exchange energies. A more general solution of the 5-dimensional wave equation for the components of the quantized meson field is then obtained in the form of a multiple Fourier series. N. S. JAPOLSKY

530.145

4906. Advanced and retarded solutions of generalized field-equations. H. LEHMANN AND H. STEINWEDEL. Note in *Z. Naturforsch.*, **7a**, 204–5 (*Feb.*, 1952) *In German.*

It is shown that, for the time symmetric linear generalizations of the classical field equations, solutions may not be separated into advanced and retarded potentials, and that the regularized theory leads to a non-causal equation for the motion of an electron. R. H. DALITZ

530.145

4907. On the mass-stability of electrons in the linear generalizations of classical electrodynamics. H. STEINWEDEL. Note in *Z. Naturforsch.*, **7a**, 205–6 (*Feb.*, 1952) *In German.*

For two particular form factors, the non-relativistic equation of motion (preceding abstract) for an electron in its self-field, is shown not to have the property of mass-stability. R. H. DALITZ

530.145

4908. Remarks on the insertion of self-energy graphs in external lines. G. LÜDERS. Note in *Z. Naturforsch.*, **7a**, 206–7 (*Feb.*, 1952) *In German.*

By treating the electron-photon interaction as switched on adiabatically, the indeterminate self-energy insertions on external electron lines are given meaning, and Dyson's assertion [Abstr. 4487 (1949)] concerning these graphs is verified [see also Abstr. 7523 (1951)]. R. H. DALITZ

530.145

4909. On the relativistic theory of nuclear forces. III. Relativistic corrections to the interaction produced by a scalar field. M. LÉVY. *C.R. Acad. Sci.* [*Paris*] **234**, 1255–7 (*March* 17, 1952) *In French.*

The formalism described in Pts I and II [Abstr. 4135 (1952)] is used to calculate the relativistic corrections in order v/c and $(v/c)^2$ to the nucleon–nucleon interaction produced by a neutral or charge-symmetric scalar meson field. R. H. DALITZ

530.145

4910. On the relations between the coefficients of charge and of mass in the subtractive field theory. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **234**, 1505–7 (*April* 7, 1952) *In French.*

To connect two forms of the subtractive field theory [Abstr. 838, 5102 (1951)] without the appearance of divergencies, a series of relations $\sum_1^n \varepsilon_i(\mu_i)^{2(p-1)} = 0$ $(1 \leqslant p \leqslant n)$ must be satisfied, where ε_i, μ_i are the charge and mass associated with the i-th of the n vector fields interacting with the electron. R. H. DALITZ

530.145

4911. On the gradient invariance of the theory of the vacuum. D. A. KIRZHNITS. Letter in *Zh. Eksper. Teor. Fiz.*, **21**, 949–51 (*No.* 8, 1951) *In Russian.*

In contradiction with the conclusions of Abrikosov and Khalatnikov [Abstr. 8509 (1951)] it is shown that the occurrence of divergencies of higher order than logarithmic in calculations of vacuum polarization by a magnetic field does not depend on the special form of the potential. The result, that difficulties present for a magnetic field are absent for an electric field, is not correct. W. J. SWIATECKI

530.145

4912. Mathematical aspects of the quantum theory of fields. III. Boson field interaction with a given source distribution. K. O. FRIEDRICHS. *Commun. Pure Appl. Math.*, **5**, 1–56 (*Feb.*, 1952).

For Parts I–II, see Abstr. 2433 (1952). Part III solves explicitly the problem of a quantized boson field interacting with a given source distribution. For time-independent sources, the interaction energy is shown to tend, as $t \to \infty$, to that given by a Yukawa potential interaction between sources. For bosons of zero mass, the number of particles in the field is shown to be infinite in general, and this infrared catastrophe is discussed. A representation in terms of "modified particles" is given, and is expressed by a canonical transformation. In the modified "vacuum" state, the probability of finding n unmodified particles follows a Poisson distribution. It is pointed out that, strictly, no scattering operator exists for the problem, though asymptotic transition probabilities do exist. The study is extended to non-stationary sources, with a detailed discussion of an "infinitely slow switch-on" of the interation, and the formalism is expressed in a Lorentz-invariant form. R. H. DALITZ

530.145

4913. The second-quantized theory of spin-½ particles in the nonrelativistic limit. R. K. OSBORN. *Phys. Rev.*, **86**, 340–7 (*May* 1, 1952).

The second-quantized Dirac Hamiltonian for free electrons is transformed by a canonical transformation to a representation in which the positive and negative energy wave operators are separately represented by two-component operators. The transformation employed is the second-quantized analogue

of the one derived by Foldy and Wouthuysen in their discussion of the one-particle Dirac theory and its nonrelativistic limit. This transformation is then applied to the wave operators and the Hamiltonian in the second-quantized, charge-conjugate formalism for Dirac particles. The wave operators for positrons and electrons become linearly-independent two-component operators, and the Hamiltonian separates into an electron and a positron part, each of which contains only the corresponding two-component wave operators. It is also shown that by means of an appropriate, readily determinable sequence of canonical transformations, Hamiltonians for fields of spin-$\frac{1}{2}$ particles interacting via intermediary fields can also be reduced to nonrelativistic form. This is accomplished by transforming the Hamiltonian to a representation in which it is exhibited effectively as a series expansion in powers of the Compton wavelength of the spin-$\frac{1}{2}$ particle. Illustration of the method is provided by detailed examination of the case of nucleons interacting via the pseudoscalar meson field. A.

530.145

4914. Averaging of microscopic equations for e.m. field in four-dimensional form. A. S. VIGLIN. *Zh. Eksper. Teor. Fiz.*, **21**, 795–802 (*No.* 7, 1951) *In Russian.*

A method of averaging e.m. fields of atomic or molecular ("microscopic") dimensions is developed with a view to applying it to the calculation of their bulk ("macroscopic") effects. A general theorem is proved from which the averaging formula is derived. The analysis is based on the expression of e.m. field in the form of 4-dimensional tensor of second rank. The theorem and the averaging formula, however, are proved in a general way for an m-dimensional tensor of $n+1$ rank. The results are applied, in particular, to electron currents, combining displacement and convection currents, which are presented in the specially-relativistically invariant form as 4-vectors. N. S. JAPOLSKY

530.145

4915. Unified description of leptons. V. VOTRUBA AND M. LOKAJÍČEK. Letter in *Phys. Rev.*, **86**, 260 (*April* 15, 1952).

It is shown that the description of a lepton as a particle with isotopic spin 1 [Abstr. 2422 (1952)] is independent of the special choice of the representation of the Dirac γ's and the isotopic spin matrices ξ. W. J. SWIATECKI

530.145

4916. Covariant theory of radiation damping. J. PIRENNE. *Phys. Rev.*, **86**, 395–8 (*May* 1, 1952).

Schwinger's expression of the S matrix in the Cayley form, in terms of a Hermitian operator K, is shown to be identical with the previous noncovariant expression used in Heitler's theory of radiation damping. The comparison of the two formalisms leads, furthermore, to a clear understanding of mass renormalization which is necessary for internal consistency, quite independently of the eventual removal of divergences. For the computation of $\bar{K}$ in a covariant way new formulae generalizing and connecting Gupta's, and Fukuda and Miyazima's results are presented. The nth order approximations of $\bar{K}$ and S are closely related, and $\bar{K}_n$ may be expressed in terms of the S_p of order $p \leq n$ or in terms of their anti-Hermitian parts only. A.

530.145

4917. Difference between particles and antiparticles subject to Dirac's equation. M. A. MARKOV. *Zh. Eksper. Teor. Fiz.*, **21**, 761–9 (*No.* 7, 1951) *In Russian.*

A more detailed presentation of earlier results [Abstr. 5523 (1950)]. Consideration of interaction of neutrinos with field of heavy particles, e.g. proton–neutron, allows in principle the distinction between neutrino and antineutrino. J. JACOBS

530.145

4918. On the representation of the field of a Dirac magnetic monopole by a vector potential. T. NEUGEBAUER. *Z. Naturforsch.*, **7a**, 154–6 (*Feb.*, 1952) *In German.*

The magnetic field of a magnetic monopole is described by a vector potential which is singular along an arbitrary line. This singularity corresponds to Dirac's "unobservable string" [Abstr. 859 (1949)] which connects two monopoles of opposite sign. R. H. DALITZ

530.145

4919. Note on configuration probabilities. A. J. F. SIEGERT. *J. Chem. Phys.*, **20**, 572–3 (*April*, 1952).

The series obtained by Goldberger and Adams are derived by a simpler method and generalized to include systems of particles with Bose and Fermi statistics and spin, if spin-dependent terms in the Hamiltonian are neglected. A.

530.145

4920. Elementary spinor theory. W. T. PAYNE. *Amer. J. Phys.*, **20**, 253–62 (*May.*, 1952).

The basic part of the theory is developed by elementary means with the use of a simple picture of a spinor and spherical trigonometry. The topics treated are the geometrical description, components, equations for the rotation, determination of the magnitude function, and addition and multiplication of spinors. The relation to quaternions is briefly discussed. No detailed treatment of the physical applications of spinor theory is given. A.

530.145

4921. Exchange-collisions of fast nucleons with deuterons. I. I. YA. POMERANCHUK. *Zh. Eksper. Teor. Fiz.*, **21**, 1113–22 (*No.* 10, 1951) *In Russian.*

The influence of binding in the deuteron, together with the Pauli principle, allow the spinor-dependence of exchange forces to be determined. These make possible a comparison of the cross-sections of exchange collisions of fast nucleons with deuterons and free nucleons. Results of recent investigations on collisions of fast neutrons with deuterons [Abstr. 4765 (1951)] are less general. J. JACOBS

530.145

4922. Nuclear phenomena deducible from μ-pair theory with pseudoscalar coupling. L. M. TANNENWALD. *Phys. Rev.*, **86**, 332–9 (*May* 1, 1952).

The case of pseudoscalar coupling between nucleons

and μ-field is considered within the framework of μ-pair theory. Besides the usual perturbation treatment, the strong coupling approximation for this case is developed. Both methods are applied to the problems of scattering of μ-mesons by nucleons and the nucleon–nucleon interaction. Interpolation between the extremes of weak and strong coupling suggests that this μ-pair theory may be promising with an intermediate coupling strength, a condition also required by the μ-pair theory of the π-meson. A.

530.145

4923. Equivalent potentials with related eigenvalue spectra in Schrödinger equations. E. FUES AND H. STATZ. *Z. Naturforsch.*, **7a**, 2–9 (*Jan.*, 1952) *In German.*

It is shown that under certain conditions deep and narrow potential wells have a negligible influence on the main energy spectrum of a wavemechanical problem. P. T. LANDSBERG

530.145

4924. On a type of operator calculus applicable to the theory of perturbations. A. VISCONTI. *C.R. Acad. Sci.* [*Paris*] **234**, 1252–5 (*March* 17, 1952) *In French.*

A study of solutions $U(t,t_0)$ of $i\partial U/\partial t = H(t)U$, $(U(t_0,t_0) = 1)$, on the assumption that a domain D_t exists within which this equation is equivalent to the integral equation $U(t,t_0) = 1 - i\int_{t_0}^{t} H(\tau)U(t,t_0)d\tau$.

R. H. DALITZ

530.162

4925. Gentile's intermediate statistics. D. TER HAAR. Letter in *Physica*, **18**, 199–200 (*March*, 1952).

In this statistics, the maximum number of particles in any one non-degenerate energy level is neither 1 (Fermi–Dirac) nor ∞ (Bose–Einstein) but a finite number. An expression for the probability $W(Ni)$ of a distribution where the number of particles in the ith level is N is derived and shown to be the same as that given by the Bose–Einstein statistics. T. C. TOYE

530.162

4926. The perfect Bose–Einstein gas in the theory of the quantum-mechanical grand canonical ensembles. D. TER HAAR. *Proc. Roy. Soc. A*, **212**, 552–8 (*No.* 1111, 1952).

The theory of quantum-mechanical grand canonical ensembles is used to derive for the case of a perfect Bose–Einstein gas the average number of particles in the different energy levels, the fluctuations in these numbers and the equation of state. The Einstein condensation phenomenon is then discussed, and it is shown that in a p–v diagram (v being the specific volume) the isotherm consists of two analytically different parts in the limit where the number of particles in the system, N, goes to infinity. It is also shown that for finite N at the critical volume $\partial^n p/\partial v^n$ is of the order $N^{\frac{1}{2}(n-2)}$ in accordance with a result obtained by Wergeland and Hove–Storhoug. A.

530.162

4927. The analysis of observations. E. W. BASTIN AND C. W. KILMISTER. *Proc. Roy. Soc. A*, **212**, 559–76 (*No.* 1111, 1952).

A new method of approach to Eddington's wave-tensor calculus is given. The basis of the method is the concept of scale invariance. This leads to the idea of a scale basis for the algebra employed, and it is shown that this is only possible for the even Clifford algebras. Thus the origin of the E-number algebra is clearly shown, and the requirement of scale invariance then defines a four-dimensional space in which E-numbers are to be represented. The theory is carried far enough to provide for the simplest physical application—the fine-structure of the hydrogen spectrum—and the connection with Eddington's statistical theory is also discussed. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.258

4928. The bending and twisting of anisotropic plates. R. F. S. HEARMON AND E. H. ADAMS. *Brit. J. Appl. Phys.*, **3**, 150–5 (*May*, 1952).

The theory of the deflection of anisotropic plates under bending and twisting loads is summarized; experimental methods for investigating the theory are described and tested on metal plates. The results of experiments on plywood cut at various angles to the grain are given and found to conform with the theory. A.

531.259

4929. Finite deformation of an elastic solid. F. D. MURNAGHAN. *New York, John Wiley and Sons*; *London, Chapman and Hall* (1951) 140 *pp.*

The general state of stress and the general state of finite strain at any point in an elastic medium are each represented by a matrix. Rules are derived for transforming the stress and strain matrices when the coordinate system is changed, and a matrix notation is then used throughout to develop the theory of finite deformation (an elementary introduction to matrix algebra is first given). General stress-strain relations are derived for a material with an arbitrary elastic energy expressed as a function of the strain matrix. The remainder of the book treats materials in which the elastic-energy function can be expanded as a series of terms of increasing degree in the strain matrix elements, and in which terms of higher degree than the 3rd are negligible. Such an approximate theory is adequate to explain the behaviour of Na in compression up to 10^5 atm. Anisotropic materials of this type have in general 21 2nd-order and 56 3rd-order elastic constants; the simplifications arising from the possible types of crystal symmetry are treated. Simple shear, simple tension, compression of a spherical shell and of a circular tube, and torsion of a circular cylinder, are discussed in detail.

J. G. OLDROYD

531.3

4930. Can the impact of a falling chain be measured by a balance? G. F. HULL. Note in *Amer. J. Phys.*, **20**, 243–4 (*April*, 1952).

Lamb's problem of the instantaneous pressure exerted by a falling chain on a horizontal table and those of Miller and Satterly (1951), involving a balance-pan in place of the table, are shown to be incompatible.

The spring balance and the two-pan, equal-arm balance are considered. A solution, using the principle of momentum, is given for the spring balance and experimental results for a chain, hanging half-down and half-up, and hooked at mid-point half-down and half-up, are in agreement. It is concluded that there is no satisfactory theory of the pan balance problem and that this instrument is a crude device for indication of the impact. S. WEINTROUB

MECHANICAL MEASUREMENTS 531.7

531.77 : 621.317.39

4931. Electrical measurement of angular acceleration and torque. V. MODONI. *R.C.* 51 *Riun. Ass. Elettrotec. Ital.*, 1950, *Fasc.* 2, 77–84 (*Paper* 116, 1951) *In Italian.*

Lemonosoff's method uses a tachometer generator supplying a resistance and the primary of a mutual inductance, the secondary of which is connected to an ammeter. In Yttenberg's method the generator supplies a resistance and a capacitor in series with the meter. Heiler uses a magneto-electric voltmeter. In Finzi's method a separately excited generator supplies a separately excited d.c. motor on no load. The author uses a tachometer generator in connection with a 2-valve circuit, the terminals being connected to the grids. The theory of these methods is given and the accuracy is discussed. Some electro-mechanical and piezo-electrical methods, and methods based on variation of resistance of compressed powders, on variation of capacitance and of reluctance of a magnetic circuit, are also discussed.

J. A. WILCKEN (R)

531.787

4932. The Dubrovin manometer. H. v. UBISCH. *Fra Fys. Verden*, **13**, 202–6 (*No.* 4, 1951) *In Norwegian.*

Explains the working principle and gives the mathematical theory. K. JOHNSEN

531.787 : 535.551

4933. Measurement of die pressures in wire drawing by photoelastic methods. P. M. COOK AND J. G. WISTREICH. *Brit. J. Appl. Phys.*, **3**, 159–65 (*May*, 1952).

531.788.6 : 621.317.79

4934. Hot-wire manometers. G. VON DARDEL AND H. VON UBISCH. *Tekn. Tidskr.*, **82**, 203–8 (*March* 4, 1952) *In Swedish.*

The determination of heat conductivity of gases by a 0·01 mm dia. tungsten wire extended in a 10–20 mm dia. glass tube, the wire forming one arm of a Wheatstone bridge, is described and Knudsen's formula for the molecular conductivity, valid for pressures $< 10^{-3}$ torr, and for conductivity at high pressures are discussed. Voege's thermo-cross and Pirani's resistance manometers are described. The volt/ampere characteristics for pressures of 0–10 torr are given and the working-lines for const. current, const. voltage, const. power, and const. temperature, are shown. A complete circuit diagram for a const. temperature manometer is given. Calibration curves for the various types are shown. J. A. WILCKEN

531.791

4935. Automatic counting of microscopic particles. W. H. WALTON. *Nature* [*Lond.*] **169**, 518–20 (*March* 29, 1952).

Report of two discussions on the measurement of the number and size of fine particles. The following methods are outlined: "double scan" method, intercept length method, guard spot method and the "memory" or "sequential signal" method.

H. P. MYERS

MECHANICS OF FLUIDS 532

532.13

4936. Measurement of the shear modulus of viscous liquids. H. FROMM AND W. HARTUNG. *Technik*, **7**, 126–30 (*March*, 1952) *In German.*

A concentric cylinder method in which forced rotational vibrations are transmitted through the test liquid to a freely oscillating cylinder whose response is measured in amplitude and relative phase. Neglecting liquid inertia, the shear modulus in the Maxwell equation is fixed by the frequency at which the phase shift is 90°. When inertia is taken into account the simple analysis is inapplicable and the new formulae give paradoxical results for six liquids. This provides further evidence that the Maxwell equation is of limited validity. R. O. DAVIES

532.13 : 532.73 : 541.182.6

4937. The viscosity of concentrated suspensions and solutions. H. C. BRINKMAN. *J. Chem. Phys.*, **20**, 571 (*April*, 1952).

An expression for the viscosity of solutions and suspensions of finite concentration is derived by considering the effect of the addition of one solute-molecule to an existing solution, which is considered as a continuous medium. A.

532.137

4938. A vibrating plate viscometer. J. G. WOODWARD. *J. Coll. Sci.*, **6**, 481–9 (*Oct.*, 1951).

A constant force, derived electromagnetically, drives a reed immersed in a liquid at its mechanical resonance frequency. A voltage, produced piezo-electrically from the amplitude, is proportional to the latter and to $\eta\rho$ of the liquid. The voltmeter scale is calibrated in $\eta\rho$ units, using known liquids. Range 10^{-1} to 10^{5} centipoise and minimum vol. test liquid 0·5 ml. J. E. CAFFYN

532.51

4939. Bernoulli's theorem for viscous fluids. J. J. VAN DEEMTER. Letter in *Phys. Rev.*, **85**, 1049 (*March* 15, 1952).

Truesdell [Abstr. 3814 (1950)] and Etkin and Szebehely [Abstr. 2412 (1951)] have derived the form of Bernoulli's theorem for a viscous fluid, not conducting heat, by modifying the impulse equation.

Madelung (1943) and Lohr (1939) have derived a modification of the theorem in the case of steady flow, neglecting extraneous forces and heat conductivity by taking the dot product of the impulse equation by v and so forming the energy equation. Madelung's derivation is now extended to any motion of a general viscous fluid. Forms of the theorem applicable to steady flow of a perfect gas or of an incompressible fluid are derived as special cases of the general theorem. The classical Bernoulli "constant" varies along a stream line due to heat flow by conduction and to flow of dynamical energy caused by viscous forces. J. S. G. THOMAS

532.51

4940. Elementary solutions of the equations governing the flow of compressible fluids. P. GERMAIN. *C.R. Acad. Sci.* [*Paris*] **234,** 1248–50 (*March* 17, 1952) *In French.*

Elementary forms of solution of the equation $\mathscr{L}(u) = u_{zz} + k(z)u_{xx} = 0$ governing the flow of compressible fluids are derived by the use of an extension of the Fourier transformation suggested by Schwartz (1951). The procedure can be applied to generalize some results already derived from Tricomi's equation. J. S. G. THOMAS

532.593

4941. Water waves over sloping beaches and the solution of a mixed boundary value problem for $\Delta^2\varphi - k^2\varphi = 0$ in a sector. A. S. PETERS. *Commun. Pure Appl. Math.*, **5,** 87–108 (*Feb.*, 1952).

Periodic solutions of the linearized differential equation for the velocity potential are sought, corresponding to progressive waves whose curves of constant phase become parallel straight lines making an arbitrary angle with the shore line at great distances from the shore. The equation is reduced by change of variables to Laplace's equation in two dimensions, which is then solved with the appropriate boundary conditions. J. G. OLDROYD

CAPILLARITY 532.6

532.61.08

4942. The ring method of measuring surface tension for liquids of high density and low surface tension. H. W. FOX AND C. H. CHRISMAN, JR. *J. Phys. Chem.*, **56,** 284–7 (*Feb.*, 1952).

The existing correction tables applicable to the measurement of surface tension by the ring method are not extensive enough to be used with liquids of high density coupled with low surface tension, as, for example, the fluorocarbons. The tables have therefore been extended by fitting a combined hyperbolic and linear equation to the curves derived from existing tables. This equation produces values in agreement with existing tables to better than 0·05%. The extrapolated tables were verified experimentally over their whole range by comparing measurements of the surface tensions of five fluorocarbon liquids made by the differential capillary-rise method (which is independent of corrections) with measurements on the same liquids made by the ring method. The agreement was as good as that associated with the original tables. A.J.

532.613.4 : 541.182.4

4943. Time-dependence of boundary tensions of solutions. III. Thermodynamics of the boundary-bulk equilibrium of fatty acids in hexane-water systems. A. F. H. WARD AND L. TORDAI. *Rec. Trav. Chim. Pays-Bas*, **71,** 482–9 (*April*, 1952).

For Pt II, see Abstr. 4162 (1952). The activity of the solute in the adsorbed layer is calculated, and from this is obtained the activity in bulk by means of interfacial tension data at very low concentrations, using the method previously devised by the authors. This allows the investigation of the equilibrium between single and associated fatty acid molecules in hexane. It is shown that there is a simple equilibrium between monomers and dimers with lauric and palmitic acids, and the standard free energy of dimerization is calculated, but the equilibrium with stearic acid is more complicated. The standard free energy of adsorption is calculated and is found to be independent of the chain-length of the acid. A.

532.65

4944. Surface structure of water and some of its physical and chemical manifestations. W. A. WEYL. *J. Coll. Sci.*, **6,** 389–405 (*Oct.*, 1951).

The difference in polarization of the positive and negative ions causes the more polarizable (i.e. the −) to be pushed towards the exterior and the less polarizable (the +) to withdraw slightly towards the interior, in order to reduce the surface energy. The effect is particularly marked in water because of the non-polarization of the H^+; the surface of the water droplet thus consists of a layer of O^{--} or OH^- ions followed by a layer of H^+, giving an electrical double layer; small droplets thus repel one another on collision (with large droplets the greater inertia overcomes the repulsive forces). There must be a transition from the "abnormal" atomic structure of the surface layer to the structure of ordinary water in the interior, and this requires a finite distance—perhaps some hundreds of atomic layers. Hence a water droplet must have a certain minimum size S to be stable, and S will be a function of temp. Essentially, then, ice is covered with a liquid film, which is in equilibrium with the ice. The significance of these conceptions for regelation, for the slipperiness of ice, for ballo- (waterfall-) electricity, for luminescence brought about by grinding (triboluminescence) and by ultrasonic vibrations (sonoluminescence), and also for the oxidation which occurs when water is exposed to strong ultrasonic radiation, is considered in some detail. S. J. GREGG

532.694.1

4945. Mechanical destruction of young and old foam films. J. J. BIKERMAN. *J. Phys. Chem.*, **56,** 164–5 (*Feb.*, 1952).

Single foam films (1·0–3·5 cm in diameter) were broken by a stream of mercury droplets. Fresh films (e.g. 5 sec old) lasted longer than aged films (e.g. 60 sec old). Similarly, fresh films endured more punctures by a glass needle than older films. This

result is in agreement with Rayleigh's theory of foams. It indicates also that mechanical devices for foam destruction are likely to be less efficacious the fresher the foam. The persistence of untouched single films was shorter for larger films; in several instances it was inversely proportional to the film area; apparently, this cannot be accounted for by the probability theory of rupture. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 541.132

4946. A criterion of electrolytic dissociation for fused salts. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **234**, 1283–4 (*March* 17, 1952) *In French.*

In a previous paper [Abstr. 807 (1952)] the author showed how latent heats of fusion can be calculated on the hole theory. In the case of the rare gases the entropy of fusion was found to be very nearly 3 as predicted by the theory. In the present paper this ratio is found to be very close to 6 for fused salts, there being twice the number of holes per mole due to dissociation. T. C. TOYE

532.72

4947. Some measurements of the self-diffusion coefficients of liquids. K. GRAUPNER AND E. R. S. WINTER. *J. Chem. Soc.* (1952) 1145–54 (*March*).

By use of deuterium as tracer element, the self-diffusion coefficients of water, benzene, bromoethane and ethanol have been measured over the temperature range 15–45°. For water, some measurements have also been made by using O^{18}. A.

532.72

4948. Tracer-diffusion in liquids. I. Diffusion of tracer amount of sodium ion in aqueous potassium chloride solutions. J. H. WANG. *J. Amer. Chem. Soc.*, **74**, 1182–6 (*March* 5, 1952).

A method of measuring the diffusion of tracer amount of a radioactive ion in salt solution is developed. The diffusion coefficients of tracer amount of radioactive Na ion in aqueous KCl solutions of concentration between 0·00494 and 4·14 formular weight per litre are determined. It is shown that the "tracer-diffusion" coefficients as calculated by the Onsager theory agree with the measured values at various concentrations from infinite dilution up to about 0·05 formular weight per litre within experimental uncertainties. Above 0·1 formular weight per litre the coefficient first increases, reaching a maximum value near 1·3 formular weight per litre, and then starts again to decrease with increasing salt concentration. A qualitative explanation of the concentration dependence of the coefficient is attempted. A.

532.72

4949. Self-diffusion of aliphatic alcohols. J. R. PARTINGTON, R. F. HUDSON AND K. W. BAGNALL. Letter in *Nature* [*Lond.*] **169**, 583–4 (*April* 5, 1952).

Values for the activation energies have been obtained from measurements of the self-diffusion coefficients for water and certain alcohols. The results are not entirely in agreement with Eyring's view on diffusion. A more detailed report is intended. T. C. TOYE

532.739 : 537.226 : 537.214

4950. The electrostatic energy of molecules in solution. W. B. BONNOR. *Trans Faraday Soc.*, **47**, 1143–52 (*Nov.*, 1951).

A formula for the electrostatic energy of a dissolved spherical molecule is deduced in terms of its charge distribution, its polarizability and the dielectric constant of the solution. The theory is applied to solutions of water in various alcohols and of ethyl alcohol in *n*-heptane, treating the solute molecule as a point dipole at the centre of a sphere of polarizable material. In most of these solutions it is found that deviations from Raoult's law can be accounted for by the electrostatic energy of the solution. From the theory a formula is derived for the change in electrostatic energy when an external electric field is applied to a solution. A.

532.74

4951. Orientation effects in solutions of alcohols. J. BARKER. *J. Chem. Phys.*, **20**, 794–800 (*May*, 1952).

An attempt is made to relate the free energy, heat and entropy effects involved in the solution of alcohols in nonpolar solvents with the molecular interactions in the solutions. A simple model for the alcohol molecules is proposed, and the thermodynamic functions for a one-dimensional array, and in a simple case for a three-dimensional array, are determined by the methods of statistical mechanics. The results for the three-dimensional array are used to examine the assumption of "repeatable step" association with a definite equilibrium constant, and cast some doubt on the justification for this assumption. It is concluded that a more complete treatment of the three-dimensional array should provide a satisfactory basis for the complete description of the experimental facts. A.

532.77 : 532.123

4952. Visco-elastic effect in solutions of simple particles. G. K. FRAENKEL. *J. Chem. Phys.*, **20**, 642–6 (*April*, 1952).

Calculations are performed on a simple model to show that dilute solutions of asymmetric particles possess a frequency-dependent intrinsic viscosity and a rigidity. The model used is that of a solution containing elastic dumbbells, that is, particles consisting of two rigid bodies held together by elastic forces. Part of the rigidity would also arise from inelastic dumbbells and is caused by a force, usually neglected, as a result of Brownian motion. An additional rigidity is caused by the elastic nature of the dumbbells. At sufficiently low or high frequencies the results approximate a form similar to the ordinary dispersion formula for the dielectric constants of solutions and involve two relaxation times, one at low frequencies and one at high frequencies. The results for inelastic dumbbells are described by one relaxation time and follow the usual dispersion curve for all frequencies. A.

MECHANICS OF GASES 533

533.15

4953. Diffusion properties of gases. V. The thermal diffusion of carbon monoxide, nitrogen and methane. A. N. DAVENPORT AND E. R. S. WINTER. *Trans Faraday Soc.*, **47**, 1160–9 (*Nov.*, 1951).

For Pt IV, see Abstr. 8568 (1951). The factors have been determined at three, two and two temperatures respectively. The figures agree reasonably well with those calculated using the 13 : 7 intermolecular force model. A coaxial cylinder thermal diffusion column 316 cm long has been used to study the separation of C^{13} in carbon monoxide and of N^{15} in nitrogen. The results have been compared with the predictions of the theory of Furry and Jones, and the parasitic remixing term K_p evaluated. Values of K_p for a number of thermal diffusion columns are compared. A.

533.15

4954. Thermal diffusion in the presence of a dissociating gas. E. WHALLEY. *Trans Faraday Soc.*, **47**, 1249–55 (*Dec.*, 1951).

The effect of the presence of a dissociating gas on the separation of two gases by thermal diffusion is examined theoretically using the mean free path theory of gases. Calculations have been performed of the separation of hydrogen and nitrogen in the presence of nitrogen peroxide. The relative concentration gradient of two gases may be either increased or reduced, depending on the relative masses and diameters of the molecules and upon the sign of the temperature coefficient of the equilibrium constant for the dissociation. A.

533.16

4955. The Lennard–Jones 12 : 6 potential and the viscosity of gases. E. WHALLEY AND W. G. SCHNEIDER. *J. Chem. Phys.*, **20**, 657–61 (*April*, 1952).

The viscosity of several simple gases is discussed with reference to the Lennard–Jones 12 : 6 potential. The predicted and experimental viscosities agree well at moderate temperatures, but the agreement is not so good at higher temperatures, and for some gases, no possible choice of the force parameters will predict the correct temperature variation of the viscosity at high temperatures. A.

533.5

4956. Flat vacuum valve operated by a Mönch handscrew. S. ROBIN AND B. VODAR. Letter in *J. Phys. Radium*, **13**, 110 (*Feb.*, 1952) *In French.*

A vacuum valve, in use in a vacuum monochromator, is described and illustrated. It consists of a welded rectangular steel case with an opening 90 mm dia. A valve in the steel box ensures gas tightness in the closed position, while it is completely removed from the pumping path in the open position.

G. WITTENBERG

533.5 : 531.788.7

4957. An easily degassable ionization gauge with a simple and stable circuit. N. WARMOLTZ AND E. BOUWMEESTER. *Appl. Sci. Res. B*, **2**, 273–6 (*No.* 4, 1952).

An ionization gauge of the tetrode type is described, with two grids and a thin ion collector on the glass wall, which is degassable by heating it in an oven and passing current through the grids. The electron current is stabilized by the first grid. For measuring the ion current a balanced bridge d.c. amplifier with one tube is used. A.A.

533.5 : 621.385.1.032.46

4958. The production of very high vacua by the use of getters. S. WAGENER. *Proc. Instn Elect. Engrs, Pt* III, **99**, 135–47 (*May*, 1952).

An attempt has been made to integrate all information which might lead to a fuller understanding of the physico-chemical processes occurring on and in getter materials. Both original research results and published work from other sources are included. The characteristics of getters are defined and correlations between them are derived. Methods for measuring the characteristics are described and values of these for different getters and gases are given. Two main mechanisms of the gettering process are distinguished, namely contact gettering and discharge gettering, of which the latter, on account of the higher gettering rates attainable, is found to be of chief importance for the production of very high vacua. The processes contributing to discharge gettering are investigated in detail, and an attempt is made to determine the parts played by adsorption, diffusion and chemical reaction in different systems of getters and gases. The efficiency of flash getters is compared with that of coating getters, particularly thorium. It is found that gases like oxygen and carbon dioxide are taken up irreversibly during discharge gettering with thorium. The pressures attainable in valves using flash and coating getters are measured, and the influence of baking time on the pump and pressure during sealing-off are investigated. A.

533.6.011 : 534.26

The use of ultrasonic waves for the study of an aerodynamic field. *See Abstr.* 4982

533.6.011.5

4959. Supersonic flow through nozzles with rotational symmetry. Y. W. CHEN. *Commun. Pure Appl. Math.*, **5**, 57–86 (*Feb.*, 1952).

Three-dimensional study of supersonic flow, with cylindrical symmetry is governed by a system of hyperbolic differential equations in two independent variables. The equations are singular along the axis of symmetry, and owing to this singularity, problems dealing with flow in the neighbourhood of the axis cannot be treated within the framework of the well-known theory of such equations (Lewy, 1927). The following problem is posed and discussed: Suppose the states of flow are given along two characteristics C_+ (forward) and C_- (backward) issuing from a point on the axis of symmetry: Does there exist a continuous flow with continuous first derivatives in the region between C_+ and C_-? If v denote the radial velocity component at a distance y from the axis of symmetry, then the question can be answered in the affirmative provided that along each of the characteristics the prescribed values of v tend to zero with the order y^γ where γ is $> \frac{1}{2}$. For the flow through a perfect nozzle ($v = 0$), a solution is derived in the form of a convergent series. The

determination of the nth term of the expansion leads to a boundary-value problem for a system of ordinary linear differential equations with coefficients depending on n, and having singularities of well-known type at the two end points. The solutions are solved with the aid of hypergeometric functions. An expansion of the solution is derived in terms of polar co-ordinates. Existence and uniqueness theorems in the plane of characteristic parameters are established, and consequences of these theorems for the flow in the physical plane are established, and the propagation of 1st-order disturbances along C_+ and C_- are studied. J. S. G. THOMAS

533.6.011.5

4960. Remark relating to shock waves in plane flow. J. LEGRAS. *C.R. Acad. Sci.* [*Paris*] **234**, 1432–4 (*March* 31, 1952) *In French.*

The form of shock waves produced at a rhombic (lozenge shaped) profile in a plane supersonic flow is studied, to a first degree of approximation, by parametric representation. The results show that the waves are, to a very considerable degree, analogous to those produced by a parabolic profile. Generally, it is shown that, to a first approximation, the breadth of the perturbation band depends only upon the thickness of the profile and not on its shape or depth. J. S. G. THOMAS

533.6.08 : 621.317.79

4961. A recording and integrating flowmeter. D. C. PRESSEY. *Electronic Engng*, **24**, 112–16 (*March*, 1952).

The instrument described was designed to measure rates of air flow in respiration studies. It uses a flow-rate/pressure transducer, consisting of a layer of fibrous material, and a capacitance pressure gauge in an r.f. bridge circuit, with an amplifier, detector and pen amplifier enabling flow rates to be recorded as well as measured. To overcome detector non-linearity at small signal levels a portion of the oscillator output is applied to the suppressor grid of the last r.f. amplifier. An integrating amplifier and a system of relays enable volumes to be recorded. The instrument can handle flow rates of 0·05–3 l/sec., pressure of 1–50 mm water and volumes of 0·1–75 l. W. G. STRIPP (R)

MOLECULAR THEORY OF GASES 533.7

533.75

4962. On the distribution function in phase space, with application to the stationary state of an ideal gas. E. IKENBERRY. *J. Chem. Phys.*, **20**, 568–70 (*April*, 1952).

An infinite set of partial differential equations which are to be satisfied by the coefficients in a Bruns' series expansion of the distribution function, as a consequence of the principle of "conservation of density-in-phase," are obtained. By means of these equations there are derived meteorologically useful expressions for the density and temperature gradients in an ideal gas. A.

533.75 : 536.71

4963. The third virial coefficient for an intermolecular potential with repulsive energy r^{-a}. R. BERGEON. *C.R. Acad. Sci.* [*Paris*] **234**, 1039–41 (*March* 3, 1952) *In French.*

The determination from the second virial coefficient of the exponent of the repulsive term in the intermolecular potential presents considerable difficulty as the value of the coefficient is insensitive to variations in the exponent between 8 and 14. The third virial coefficient is more sensitive to such variations. Although the third coefficient has been calculated accurately in some special cases, it is of interest to calculate its value in the form of an infinite series generally applicable. The principles and some results of such an expansion are given. Numerical results are given for a special case and shown to be in good agreement with those obtained previously by Bird, Spotz and Hirschfelder. F. E. HOARE

VIBRATIONS . ACOUSTICS 534

534.112

4964. Inharmonicity of plain wire piano strings. R. W. YOUNG. *J. Acoust. Soc. Amer.*, **24**, 267–73 (*May*, 1952).

The inharmonicity of plain wire strings *in situ* has been measured in 6 pianos of various styles and makes. By inharmonicity is meant the departure in frequency from the harmonic modes of vibration expected of an ideal flexible string. It is shown from the theory of stiff strings that the basic inharmonicity in cents (hundredths of a semitone) is given by $3{\cdot}4\times10^{13}n^2d^2/v_0^2l^4$, where n is the mode number, d is the diameter of the wire in cm, l is the vibrating length in cm, and v_0 is the fundamental frequency. A value of $Q/\rho = 22{\cdot}5\times10^{10}$(cm/sec)^2 was assumed for the steel wire, where Q is Young's modulus and ρ is the density. The observations are entirely compatible with the relationship given. In general terms the inharmonicity of the plain steel strings is about the same in all the pianos tested, being about 1·2 cents for the second mode of vibration of the middle C string. Above this point every 8 semitones it is doubled. Below middle C the inharmonicity is consistently less in large pianos than in small ones. A.

534.121.1 : 539.32

4965. An improved frequency equation for contour modes of square plates of anisotropic material. R. BECHMANN. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 368–74 (*May*, 1952).

An improved approximation, based on previous work [Abstr. 5174 (1951)], has been derived for the frequency equation covering the four contour modes of vibration of square plates of anisotropic material. The modes consist of three longitudinal and one shear mode. An X-cut quartz, a Y-cut EDT and Yψ-cut lithium sulphate plates have been used as examples. The equation has been used to determine the elastic coefficients s_{55} and s_{13} of EDT and lithium sulphate monohydrate. A.

534.141.4

4966. Acoustical characteristics of jet-edge and jet-edge-resonator systems. W. L. NYBORG, M. D. BURKHARD AND H. K. SCHILLING. *J. Acoust. Soc. Amer.*, **24**, 293–304 (*May*, 1952).

A jet-edge (JE) system is an arrangement whereby a thin blade of fluid impinges on an edge and thus, under appropriate circumstances, gives rise to tones which are called edge tones. Experimental results are presented for JE systems such as might be employed in jet-edge-resonator type whistles. Operating ranges of parameters are mapped out for various possible stages of self-oscillation. Edge tone fields are described as functions of parameters, particular emphasis being given to magnitudes and distributions-in-space of stage 1 edge tone sound fields. Examination is also made of sound fields generated by a JE system coupled to a resonator; a characteristic interaction pattern is described. A.

534.22

4967. The velocity of sound in gases at low pressures. R. L. ABBEY. *Aust. J. Sci. Res. A*, **5**, 223–5 (*March*, 1952).

Previous work [Abstr. 3043 (1949)] has been repeated with improved apparatus. It is found that the velocity of sound measured in a tube at pressures below 20 cm Hg increases rapidly towards low pressures. Increases of the order 10 m/sec in the velocity of sound in air are observed below 5 cm Hg, the increase becoming smaller as the frequency increases. The effect on tube correction has been studied. A. B. WOOD

534.22

4968. Ultrasonic studies of polymethyl methacrylate. J. L. MELCHOR AND A. A. PETRAUSKAS. *Industr. Engng Chem.*, **44**, 716–19 (*April*, 1952).

The velocity of sound *v.* temperature in polymethyl methacrylate was studied by a pulsed ultrasonic beam method. At frequencies of 0·5, 1, 2, 5 and 10 Mc/s from 15° to 105°C. Breaks were observed in the curves; the temperature at which these occurred did not change strongly with frequency. A slight shift to higher temperatures with increase in frequency was observed from 0·5 to 5 Mc/s. The observed change in transition temperature over the frequency range covered was only 2° or 3°C, and this is barely outside the experimental error. Thermal expansion curves obtained for the same samples of polymethyl methacrylate exhibited a break at approximately the same temperature. Attenuation measurements at frequencies of 0·5, 1 and 2 Mc/s show an increase in attenuation with increasing frequency and temperature. A.

534.23

4969. Parameters of sound propagation in granular absorbent materials. M. A. FERRERO AND G. G. SACERDOTE. *Acustica*, **1**, 137–42 (*No.* 3, 1951).

From measurements of acoustical impedance of homogeneous absorbent materials made with the method of stationary waves, it is possible to determine the parameters of propagation. Measurements are made with two thicknesses of the material, one double the other. The procedure followed for the calculation is indicated and some diagrams are proposed to obtain more easily the parameters of propagation. Examples are given of the method proposed and the parameters are calculated for small spherical leaden balls and sand of various sizes. A.

534.23

4970. Absorption of ultrasonic waves in liquids. P. A. BAZHULIN. *Trudy Fizicheskogo Institutad P. N. Lebedeva, Vol. 5. Moscow, Akademii Nauk SSSR* (1950) *pp.* 261–338.

Doctorate thesis presented at the Lebedev Physical Institute.

534.23

4971. Absorption of sound in fluids. J. J. MARKHAM, R. T. BEYER AND R. B. LINDSAY. *Rev. Mod. Phys.*, **23**, 353–411 (*Oct.*, 1951).

A complete review of the basic concepts including the old and more modern theories. The paper forms an excellent introduction to the subject and an exhaustive list of references is given. T. C. TOYE

534.23

4972. On sound propagation in $MgSO_4$ solutions. R. BARTHEL. *J. Acoust. Soc. Amer.*, **24**, 313–16 (*May*, 1952).

Recent experimental data show that some error in concentration dependence is involved in Liebermann's application of his theory of sound propagation in chemically active media to the case of $MgSO_4$ solutions. Therefore a more careful analysis is made of the concentration dependence of some of the factors involved in the theory. The proper concentration dependence is shown to be consistent with experimental results. Present experimental data are insufficient for determining whether a unimolecular reaction or a dissociation reaction is causing the observed anomalous absorption in $MgSO_4$ solutions. A.

534.231

4973. The vibration of an air-suspended particle near a sound absorbent wall. E. MEYER AND R. W. KARMANN. *Acustica*, **1**, 130–6 (*No.* 3, 1951) *In German.*

The sound field in a tube lined with absorbent material of known impedance is investigated with the aid of particles in suspension, for frequencies between 100 and 500 c/s. The particles follow an elliptical path. From the wall impedance the axes of the ellipse and their inclination to the axis of the tube are calculated, using the theory of Morse. Theoretical and experimental results are in good agreement. A.

534.231.3

4974. Note on Beranek's theory of the acoustic impedance of porous materials. J. W. MCGRATH. *J. Acoust. Soc. Amer.*, **24**, 305–9 (*May*, 1952).

Presents a modification of the theory which avoids two approximations used formerly. It is found that the specific dynamic frictional resistance and the effective density of the material are functions of frequency. Their values may be computed from experimental values of the flow resistance, porosity, and certain area ratios which have to do with the structure of the material. A method of determining the area ratios in the isotropic case is presented. Acoustic

impedances may then be computed. The modified theory is applied to two common acoustic materials, and it appears to be quite adequate for materials of large porosity and small flow resistance. It is less adequate for other materials. Possible reasons for the latter case are discussed. A.

534.232

4975. The pressure and field calibration of microphones. A. J. KING AND C. R. MAGUIRE. *Acustica*, **1**, 123–30 (*No.* 3, 1951).

Deals with the calibration of microphones in the frequency range up to 20 kc/s. A description is given of the pressure calibration of condenser microphones in resonant tubes using Rayleigh disks for velocity measurement. The diffraction ratio is then determined using a Rayleigh disk in a lined cabinet and using a probe tube microphone in the same cabinet and also in a larger test room. The results are compared with the increase in pressure, due to the presence of the microphone, at specific points on the microphone diaphragm. The condenser microphones so calibrated may then be used to obtain the free field calibration of other microphones. A.

534.232

4976. Radiation loading of cylindrical and spherical surfaces. M. C. JUNGER. *J. Acoust. Soc. Amer.*, **24**, 288–9 (*May*, 1952).

Presents a series of curves of acoustic reactance and resistance ratios for partial waves emitted by cylindrical and spherical sound radiating sources whose dynamic configuration is expressible by infinite series. This information permits the calculation of sound pressure at the radiating surface, power of sound emitted, and accession to inertia for wavelengths and sound radiators in the range $0 \leq ka \leq 10$. A.

534.232 : 621.395.623.7

4977. A fresh viewpoint for loudspeaker development. H. HARZ AND H. KÖSTERS. *Tech. Hausmitt. NordwDtsch. Rdfunks*, **3**, 205–8 (*Dec.*, 1951) *In German.*

If the driving member of a loudspeaker is a piston-like diaphragm, the sound-radiation pattern is omnidirectional up to the frequency where the sound wavelength $\simeq$ the dia. of the diaphragm, above which it is conical. If the loudspeaker is placed in a normal room of $\sim$50 m^3 volume and reverberation time 0·5 sec, then for bass frequencies the direct wave will exceed the reflected wave over a sphere of radius 0·5 m surrounding the loudspeaker. Beyond that, the reflected wave determines the level and frequency response. At the top frequencies the same applies to the cone of radiation up to a distance of 5 m. As a result, subjective effects, similar to those of an anechoic room, are obtainable in a restricted area only, and that where the h.f. energy level is only 1% of that of the l.f. This, it is argued, accounts for the universal character of the loudspeaker response, making it distinguishable from the original sound. This effect should be removable by the use of a spherical radiator and, to simulate such a condition, 12 driving units were assembled in a dodecahedron. This assembly covered the range 400 c/s and upwards only. Accordingly, below it was mounted a vertical cylinder containing a single l.f. driving unit which radiated through a ring aperture at the top. The frequency response was sensibly flat from 40 c/s to above 10 kc/s, and the subjective response was uniform anywhere in the room. H. G. M. SPRATT (R)

534.24

4978. The reflection of a pulse by a spherical surface. D. V. ANDERSON, T. D. NORTHWOOD AND C. BARNES. *J. Acoust. Soc. Amer.*, **24**, 276–83 (*May*, 1952).

The Kirchhoff integral is applied to obtain an approximate solution for the pulse reflected from the surface of a sphere to a receiver near the source. The solution shows that for a reflection path of minimum time (in the sense of Fermat's principle) the reflected pulse should develop a "coda" and that for a path of maximum time, a "prelude." The approximations are such that the coda and prelude should have an amplitude greater than that predicted by the integral. It was found experimentally that a prelude did result from a reflection over a path of maximum time. The information from reflections over paths of minimum time was less definite, but it can be safely inferred that a coda developed as well. In addition, the pulse diffracted from the edge of an open reflector was examined and found to have the sign predicted by the integral. It can be concluded that the Kirchhoff integral can be used to give a good description of pulse reflection. A.

534.24

4979. On the failure of plane wave theory to predict the reflection of a narrow ultrasonic beam. M. S. WEINSTEIN. *J. Acoust. Soc. Amer.*, **24**, 284–7 (*May*, 1952).

In past studies of the interaction of an ultrasonic beam with a solid plate immersed in water, the general practice has been to assume that a narrow radiation pattern is a sufficiently close approximation to a plane wave to permit the use of plane wave theory to predict the results. Reflection measurements made in water with a three-degree radiation pattern at a frequency of 3·35 Mc/s, using both air-backed Al plates of thicknesses ranging from 0·250 to 0·025 in and a 2-in Al slab to approximate a semi-infinite medium, indicate that under certain conditions this assumption is not valid. Experimentally, the excess pressure of the reflected wave is considerably lower than that predicted by plane wave theory when the angle of incidence is such that the change of phase of the wave upon reflection varies greatly with a small change of the angle of incidence. It is apparent that at these angles of incidence a divergent beam which is several degrees wide cannot be used to approximate a plane wave. The nature of the phenomenon indicates that it should be of equal importance in the study of transmission phenomena. A.

534.26

4980. A theoretical model for sound scattering by marine crustaceans. S. MACHLUP. *J. Acoust. Soc. Amer.*, **24**, 290–3 (*May*, 1952).

With an eye to application in the investigation of sound scattering by marine life, the reflectivity of a spherical elastic shell containing a fluid is studied. It is found that for incident wavelengths of the order of magnitude of the sphere, the behaviour for thin

shells is similar to that of the fluid sphere alone. For longer wavelengths a correction is computed, good to terms in the first power of the thickness/diameter ratio of the shell. A.

534.26

4981. On the diffraction of an acoustic pulse by a wedge. J. W. MILES. *Proc. Roy. Soc. A*, **212**, 543–7 (*No.* 1111, 1952).

The diffraction of a pressure discontinuity by a wedge is attacked by posing the pressure as a homogeneous function of r/ct, where r, c and t are the distance from the edge, acoustic velocity and time. The scattered wave is then determined by reducing the original wave equation to Laplace's equation with the aid of a Tschplygin transformation and applying Poisson's formula to the sectoral domain cut out of the circle $r \leqslant ct$ by the wedge. The result appears in simpler form than that previously obtained by Sommerfeld. A.

534.26 : 533.6.011

4982. The use of ultrasonic waves for the study of an aerodynamic field. M. MERLE. *Acustica*, **1**, 104–8 (*No.* 3, 1951) *In French.*

In the quantitative measurement obtained by the optical methods, the verification of interferograms or striograms is indeed long and intricate. These methods, moreover, do not permit one to separate density gradients met by the same luminous ray in its crossing of the fluid. The detailed study in 3 dimensions of an aerodynamic field around a model is thereby impossible. It is shown that a narrow bundle of ultrasonic waves (normally directed to the fluid stream of a windtunnel and the luminous beam, and made visible by the optical method of streaks) permits measurement of Mach's number (by determination of the displacement of the beam), and also of the variation of the fluid temperature (by measuring the wavelength variation) and gives, besides, useful information about the state of the field around a model, of the degree of turbulence, Reynolds' criterion for a cylinder, etc. A.

534.321.3 : 534.121.3

4983. The system of the Hemony-carillons tuning. A. LEHR. *Acustica*, **1**, 101–4 (*No.* 3, 1951).

A tone-recording of three Hemony carillons (namely: Delft, Kampen and Middelstum) has been made with electronic measuring instruments. The object was to find out which sort of tuning the Hemonys used. The results show that the Hemonys used meantone tuning. A.

534.322.3 : 612.014.45

4984. Study of the biological action of complex noises of high intensity (in the ultrasonic region of the sound spectrum). P. BUGARD. *Ann. Télécommun.*, **7**, 139–43 (*March*, 1952) *In French.*

In a previous article [Abstr. 3401 (1952)] the author has described the methods of analysis of complex noises of high intensity. The present article describes an investigation of the high frequency sounds emitted from a Hartmann sound generator—a supersonic whistle of high intensity. The frequency range considered was between 30 and 60 kc/s, at an intensity of the order of 130 db. The wave form of the sound emitted by the whistle was examined by means of a C.R.O. The resulting "auditory" impression at various frequencies was recorded qualitatively as indifferent, very little disagreeable or very disagreeable. A. B. WOOD

534.41

4985. Gaseous jets sensitive to infra-sound. M. DUBOIS. *C.R. Acad. Sci.* [*Paris*] **234**, 1259–60 (*March* 17, 1952) *In French.*

Jets sensitive to very high frequency sounds are well known. The author has recently established relations between the variables—diameter of orifice, velocity of jet and frequency of sound, for jets of air emerging from cylindrical tubes, as well as for jets of other gases. It has been shown that very slow jets are sensitive to the lowest audible frequencies: 60 c/s or even less. To obtain jets sensitive to sub-audible (infra) sound the following conditions are necessary: gas at a low critical velocity, tube sufficiently large (3 or 4 mm dia.), pressure very low, in a manner resulting in a jet velocity sensibly lower than the critical velocity. Butane is particularly good on account of its low kinematic viscosity and the following jet conditions have given best results: dia. 3·23 to 3·88 mm, velocity 30 to 50 cm/sec frequency of vibration 5 to 10 c/s. A. B. WOOD

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 5479

534.773.2

4986. The subjective calibration of bone-conduction receivers for hearing aids. E. W. AYERS AND J. Y. MORTON. *Acustica*, **1**, 109–13 (*No.* 3, 1951).

To design a bone-conduction hearing aid it is necessary to know how loud a sound is produced by a given input to a receiver, but subjective calibrations by normal observers are unreliable as a guide to performance with deaf subjects. The influence of an intact air-conduction path on the subjective sensitivity of a bone-conduction receiver may be obviated by a method described, which simulates the effects of complete middle-ear deafness. Calibrations effected by this method using normal observers should be directly applicable to deaf subjects with serious middle-ear defects, but with substantially normal inner ears. Such subjects constitute the majority of those for whom bone-conduction aids are likely to be useful. A.

534.78 : 534.79

4987. On the measurement of the loudness of speech. I. POLLACK. Letter in *J. Acoust. Soc. Amer.*, **24**, 323–4 (*May*, 1952).

A previous paper [Abstr. 2328 (1952)] discussed several experimental procedures for setting up scales of loudness for white noise and for pure tones. In general the results obtained by various procedures were reasonably similar. However, when a speech signal was used large discrepancies were obtained. The present paper describes these results and presents a loudness scale for speech based upon the data available. A.

534.833

4988. Sound absorption by slit resonators. J. M. A. MITS AND C. W. KOSTEN. *Acustica*, **1**, 114–22 (*No.* 3, 1951).

A theory is presented that permits the approximate calculation of the frequency of maximum sound absorption of constructions consisting of a perforated rigid panel mounted at a short distance before a rigid wall, the perforation being a system of infinitely long parallel and identical slits. The precision seems to meet all practical requirements. The results of some experiments, corroborating the theory, are given. A comparison is made between slit perforation and perforation with circular holes. For both cases design charts are given. A.

534.833

4989. The use of perforated facings in designing low frequency resonant absorbers. D. B. CALLAWAY AND L. G. RAMER. *J. Acoust. Soc. Amer.*, **24**, 309–12 (*May*, 1952).

The effect of perforated facings of a small per cent open area on the specific acoustic resistance of backing materials of appreciable thickness was investigated for several backing materials. The resistance was found to increase by factors of 2 to 7 depending on the per cent open area of the facing and the resistance of the backing material. The increase was considerably less in all cases than $1/p$, where p is the open area ratio of the facing. It was found that the specific acoustic resistance of a resonant absorber can be varied considerably above and below the resistance of the uncovered backing by means of an air space between the facing and the porous backing. A.

534.835

4990. Impact sound in dwellings. F. INGERSLEV AND V. E. B. RANFELT. *Akad. Tekn. Vidensk. Lydtekn. Lab. Medd.*, *No.* 9, 40 *pp.* (1952) *In Danish.*

A survey of free field and laboratory measurements. The apparatus and technique used, which differ only slightly from those proposed by Parkin [Abstr. 1775 (1949)] are described. The limitations of laboratory measurements are considered but their value for obtaining relative measurements, e.g. the effect of different floor finishing is stressed. The factors which can influence the results of measurements are discussed and include calibration of the sound level meter, microphone positions, area of the floor, type of tapping machine, flanking transmission, construction and load on floor. Results for concrete and wood-joist floors are given. The value of sound level for good living conditions is discussed and it is claimed that this should not exceed an average of 55 db per 1/3 octave reduced to 0·5 sec reverberation time. G. F. HODSMAN

534.846

4991. The acoustics of the remodeled House and Senate Chambers of the National Capitol. P. E. SABINE. *J. Acoust. Soc. Amer.*, **24**, 121–4 (*March*, 1952).

The conflict between the architectural and acoustic requirements is considered and the method of compromise is indicated. Details are also given of articulation and intelligibility tests carried out in the two chambers and the results show good hearing conditions even without the aid of a public address system. G. F. HODSMAN

OPTICS . RADIATION . SPECTRA 535

535.242 : 628.971.6

4992. Photometer for measurement of street-lamp efficiency. A. MOSE-CHRISTENSEN. *Ingeniøren*, **61**, 165–6 (*March* 1, 1952) *In Danish.*

In order to be able to measure light intensity at 8–12 m from street lamps *in situ* and determine polar distribution curves, a photometer was built with a large mirror which could be turned 360° on a horizontal axis by an electric motor and which reflects the light from the lamp on to a photocell screened from direct illumination. Direction of the mirror is controlled by sighting-arrangement in the hollow shaft. J. A. WILCKEN (R)

535.245.1 : 621.314.634 : 621.383.5

4993. A method of correcting the cosine error of selenium rectifier photocells. G. PLEIJEL AND J. LONGMORE. *J. Sci. Instrum.*, **29**, 137–8 (*May*, 1952).

Describes a method for correcting the deviation from the theoretical value of the response of Se rectifier photoelectric cells to obliquely incident light. The principle of operation whereby the degree of correction can be controlled to suit different types of cells, is briefly outlined. The unit has been designed primarily for use in model rooms, and for this reason it has been made as compact as possible. It has applications in all branches of photometry and illuminating engineering where the accurate measurement of light is of fundamental importance. A.

535.317.1 : 535.361.1

4994. The distribution of light in the image of a point source formed by an instrument containing a perfectly diffusing screen. M. CAGNET. *C.R. Acad. Sci.* [*Paris*] **234**, 1271–3 (*March* 17, 1952) *In French.*

The image formed by the objective of an optical instrument falls upon a perfectly diffusing screen. The reflected or transmitted light is then viewed by an eyepiece. The distribution of light in the final image is found as a function of the pupil sizes and magnification. The diffraction pattern is found to be less favourable than that formed by an instrument without the screen. R. W. FISH

535.317.6 : 518.5

4995. Search for a mechanizable method of calculation for an optical instrument. J. PELTIER. *Rev. Opt.* (*Théor. Instrum.*) **31**, 219–28 (*May*, 1952) *In French.*

The design of optical systems is improved by using convergence ratios as variables. New formulae are established which on the one hand, from the start of the computation, satisfy the equation of convergence once and for all, and on the other hand readily take account of all the conditions demanded by the initial lay-out; the values of any geometrical components of the system required, or the sizes and relative positions

of the object and successive images. The formulae required are given without proofs, and also the schematic method of computation. A.

535.324

4996. Refractive index—temperature data for anhydrous ethyl alcohol. T. E. SMITH AND R. F. BONNER. *Analyt. Chem.*, **24**, 517–18 (*March*, 1952).

535.33.03

4997. Time-resolved spectroscopy of spark discharges. F. TSUI. *Brit. J. Appl. Phys.*, **3**, 139–40 (*May*, 1952).

Using a rotating mirror and a spectrometer, the spectra of the light emission from spark discharges in several gases have been photographed at different instants after the current-initiation. By triggering the discharge recurrently in synchronism with the mirror, the time-resolved spectral images of a number of sparks were superposed to obtain sufficient blackening on the photographic plate. The triggering circuit was activated by the rotating-mirror, and, when provided with a counter, the system could be left in automatic operation. A.

535.33.07

4998. The prismatic curvature of spectral lines. D. M. GATES. *Amer. J. Phys.*, **20**, 275–80 (*May*, 1952).

A review of the early papers on the curvature of spectral lines. The formulae for the oblique refraction of a light ray incident upon a boundary between two media are derived by means of Fermat's principle. These results are applied to the prismatic refraction of the oblique rays that originate at the off-axis positions of the spectrometer entrance slit. Three algebraic forms for presenting the resultant curvature of the slit image are given. Graphical results are presented relating the radius of curvature with the index of refraction of the prism at constant prism angles. Comparison is made with the curvature caused by reflection from a plane grating. A.

535.33.07 : 535.339

4999. Stray light in monochromators. R. DONALDSON. *J. Sci. Instrum.*, **29**, 150–3 (*May*, 1952).

A method of measuring stray light in single monochromators by means of a double monochromator is described. Various types of monochromator, employing (*a*) Littrow prism, (*b*) diffraction grating, (*c*) replica of diffraction grating, and (*d*) composite prism with only two glass-air surfaces, have been examined by this method and comparative results obtained. An experimental type of monochromator where the light traverses the same prism twice is shown to have the same order of stray light as the conventional double monochromator. With the experimental instrument set at wavelength 500 mμ, the intensity of the stray light of wavelength 480 mμ or 520 mμ was found to be less than 10^{-5} of the intensity of the directly transmitted light. A.

535.338.1

5000. The resonance emission of a discharge in cadmium vapour. YU. V. ZHARKOVA AND G. N. ROKHLIN. *Dokl. Akad. Nauk SSSR*, **81**, 175–7 (*No.* 2, 1951) *In Russian.*

Presents the results of experiments conducted in a quartz lamp of special construction, in 1947–48. A graph shows the relationship between the intensity of both resonance lines of Cd (2288, and 3261 Å) and the pressure of Cd vapour, while another graph illustrates the effect of pressure on the electron temperature, electron concentration and potential gradient. F. LACHMAN

535.338.32 : 535.35

5001. Transition probabilities for lines of Cr I and Mn I. L. HULDT AND A. LAGERQVIST. *Ark. Fys.*, **5**, 91–5 (*Paper* 6, 1952).

The following values of A, in $\sec^{-1}$, have been obtained from measurements of line-intensities in flames: Cr I $\lambda\lambda$4090, 4275, 4255; A (mean value) = $2{\cdot}78\times10^5$. $\lambda\lambda$3605, 3593, 3579; A (mean value) = $1{\cdot}13\times10^6$. Mn I $\lambda\lambda$4034, 4033, 4031 (not resolved) $A = 1{\cdot}9\times10^7$. The errors in the absolute values of A are estimated at about $\pm50\%$. R. F. BARROW

535.338.332

5002. On the magnetic decomposition of the triplet 2^3P of He I. G. HORNECKER AND P. PLUVINAGE. *C.R. Acad. Sci.* [*Paris*] **234**, 1438–40 (*March* 31, 1952). *In French.*

Theoretical. Araki's perturbation procedure for the calculation of the fine structure is extended by adding to the Hamiltonian the term $\mu H(j_z + s_z)$. The calculated magnetic separations are given in a diagram for fields up to 14 000 gauss. L. PINCHERLE

535.338.332 : 535.417

5003. Interferometric measurements of the hyperfine structure of the mercury green line. J. STERNER. Letter in *Phys. Rev.*, **86**, 139–40 (*April* 1, 1952).

Refined measurements were made with new Fabry–Perot interferometer using enriched isotope samples. The even component frequencies of 5461 Å do not lie in the atomic weights sequence. J. JACOBS

535.338.334

5004. Pressure broadening of absorption lines. G. N. PLASS AND D. WARNER. Letter in *Phys. Rev.*, **86**, 138 (*April* 1, 1952).

Equations of Lindholm [Abstr. 1850 (1946)] are used to calculate the transmission curve for an idealized band consisting of equally spaced, equally intense lines. G. F. LOTHIAN

535.338.4

5005. Structure of the emission band at 2940 Å of oxygen in an atmosphere of xenon. D. CUTHBERTSON AND R. HERMAN. *C.R. Acad. Sci.* [*Paris*] **234**, 1355–7 (*March* 24, 1952) *In French.*

535.338.42 : 536.462

5006. Emission spectrum of HCl in the near infrared. R. NEWMAN. Letter in *J. Chem. Phys.*, **20**, 749–50 (*April*, 1952).

The spectrum in the region 3000–6000 cm^{-1} emitted by the flame from a jet of Cl_2 burning in H_2 is described. The vibrational and rotational temperatures of the HCl are roughly estimated at about 2500°K. R. F. BARROW

535.34

5007. Theoretical basis of the Bouguer–Beer law of radiation absorption. F. C. STRONG. *Analyt. Chem.*, **24**, 338–42 (*Feb.*, 1952).

Presentations of the mathematical law governing

The absorption of radiation as a function of the thickness and concentration of absorbing material are customarily based upon experimental observation. A complete derivation is presented, based only upon modern theories of matter and energy. Considering the radiant power of a beam as the number of photons passing per unit time and the process of absorption as the capture of photons by molecules or ions, the probability of capture is related to a ratio of areas in an element of material. This is then integrated over three dimensions for identical photons (monochromatic radiation) to yield the familiar absorption law. The general case of a beam with a continuous distribution of wavelengths is obtained by further integration and the result is given in several forms. Graphical interpretations are presented, followed by analysis of possible methods of employing the law in practice. Finally, causes of apparent deviation are considered. A.

535.341–15

5008. The accuracy of infra-red intensity measurements. A. E. Martin. *Trans Faraday Soc.*, **47**, 1182–91 (*Nov.*, 1951).

Some of the more important errors encountered in measuring optical densities, particularly in the infra-red region, are considered. The most important errors are (i) uncertainty of the measurements of radiation, (ii) stray light error, (iii) error due to mismatch of absorption cells, (iv) inaccuracy due to non-linearity of measuring system. These errors are discussed in detail and their effect on optical density and concentration measurements in analytical applications ascertained. It is concluded that when possible the transmission of the substance examined should lie between 20 and 60%. For this range of transmissions, and assuming a probable or fixed value for each of the various sources of error, based on a general accuracy of 1%, the maximum error of a single determination of optical density can reach almost 12%, although the probable error will rarely reach 6%. Measurement of concentration can be made with greater accuracy than optical density, since errors (ii), (iii) and (iv) tend to cancel if the measured transmission is similar for both standard and unknown. Under the most favourable conditions, in the range 20 to 60% transmission, the probable error can be reduced to 1%, although in general errors up to 5% must be expected. A.

535.343 : 539.132

Spectra and electronic structure of the tetrahedral ions MnO_4^-, CrO_4^{--} and ClO_4^-. *See Abstr.* 5236

535.343–14

5009. Microwave spectra of $CHBr_3$ in the region from 11 to 12·5 centimeters. S. Kojima, K. Tsukada S. Hagiwara, M. Mizushima and T. Ito. *J. Chem. Phys.*, **20**, 804–8 (*May*, 1952).

The spectrum of rotational transition $J = 0 \rightarrow 1$ of bromoform has been estimated to lie in a 10-cm region. In this region, however, the spectroscopy has not yet been studied because of small absorption. Some of the present authors (S. K., K. T. and S. H.) had examined its detectability by the preliminary experiment with a cavity spectrometer. In the present paper more precise measurement using an absorption cell of 9 meters in length and its analysis by means of the theory proposed by some of the authors (M. M. and T. I.) are described. Thirty-two lines due to the hyperfine structure of the rotational transition were measured in the region from 2400 to 2660 Mc/s. The width of line was smaller than 2 Mc/s at 3 mmHg. The theory agreed well with the experiment. The value of the moment of inertia obtained here agrees with the result of electron diffraction, and this moment seems not to change appreciably by a low frequency deformation vibration. The quadrupole coupling constant of Br nucleus is nearly equal to that of CH_3Br molecule. A.

535.343–14 : 539.133

5010. The microwave spectra and molecular structures of trifluoromethyl bromide, iodide, and cyanide. J. Sheridan and W. Gordy. *J. Chem. Phys.*, **20**, 591–5 (*April*, 1952).

The pure rotational spectra of trifluoromethyl bromide, iodide and cyanide have been studied in the microwave region. The B_0 values in Mc/s were determined as follows: 2098·06 for CF_3Br^{79}; 2078·50 for CF_3Br^{81}; 1523·23 for CF_3I; 2945·535 for CF_3CN^{14}; 2855·859 for CF_3CN^{15}. The nuclear quadruple couplings, eQq, are in Mc/s: 619 for Br^{79}; 517 for Br^{81}; −2150 for I^{127}; −4·70 for N^{14}. With any reasonable assumption of bond angles, d_{CF} is found to be $1·33 \pm 0·015$ Å in each molecule. The other distances depend more strongly on the assumption of the bond angles. With ∠ FCF assumed to be $108° \pm 1°$, as suggested from other similar molecules, the values, $d_{CBr} = 1·91 \pm 0·02$ Å, $d_{CI} = 2·14 \pm 0·02$ Å, $d_{CC} = 1·46 \pm 0·02$ Å, are obtained, where the additional assumptions $d_{CF} = 1·332$ Å for CF_3I and $d_{CN} = 1·158$ Å for CF_3CN are made. A.

535.343–14 : 539.133

5011. The microwave spectrum of ketene. H. R. Johnson and M. W. P. Strandberg. *J. Chem. Phys.*, **20**, 687–94 (*April*, 1952).

The microwave absorption spectra of the ketene molecules $H_2^1C_2^{12}O^{16}$, $H^1D^2C_2^{12}O^{16}$ and $D_2^2C_2^{12}O^{16}$ have been investigated. Reciprocal moments of inertia have been determined for each from the measurements. The centrifugal distortion theory of Hillger and Strandberg has been found valid for both Q and R branches. The structure has been calculated and dipole moment measured; results check and extend the accuracy of values previously determined by other methods. Intensities of satellites of the lightest molecule corresponding to the lowest three vibrational fundamentals have also been measured and changes in the average reciprocal moments determined. The vibrational frequencies have been calculated and found different from values reported in the literature by infrared workers. References and suggestions for further work are given. A.

535.343–14 : 539.133

5012. The microwave spectra and molecular structures of methyl bromoacetylene and methyl iodoacetylene. J. Sheridan and W. Gordy. *J. Chem. Phys.*, **20**, 735–7 (*April*, 1952).

Pure rotation spectra of H_3CCCBr^{79}, H_3CCCBr^{81} $H_3$and CCCI were measured. For H_3CCCBr^{79}, $B_0 = 1561·11$ Mc/s, $I_B = 537·379 \times 10^{-40}$ g cm², and

$D_{JK} = +11{\cdot}4$ kc/s; for H_3CCCBr^{81}, $B_0 = 1550{\cdot}42$ Mc/s, $I_B = 541{\cdot}082 \times 10^{-40}$ g cm^2, and $D_{JK} = +11{\cdot}1$ kc/s; for H_3CCCI, $B_0 = 1259{\cdot}02$ Mc/s, $I_B = 666{\cdot}316 \times 10^{-40}$ g cm^2, and $D_{JK} = +7{\cdot}2$ kc/s. The nuclear quadrupole coupling factors (eqQ) for the halogens are: for Br^{79}, +647 Mc/s; for Br^{81}, +539 Mc/s; for I^{127}, −2230 Mc/s. On the basis of reasonable assumptions for $d_{C\equiv C}$, d_{CH} and ∠HCH, it is shown that the C — C and C — Br bonds in H_3CCCBr are shortened to extents comparable with those found in methyl acetylene and cyanogen bromide, respectively, while the I_B of methyl iodoacetylene is consistent with a similar shortening of both C — C and C — I. This is supported by the force constants for the stretching of the C — Br and C — I bonds. Bond lengths and nuclear quadrupole couplings are discussed in relation to the structures of these molecules. A.

535.343–14 : 539.133

Microwave spectra and molecular structures of fluoroform, chloroform and methyl chloroform. *See Abstr.* 5244.

535.343–15

5013. Characteristic infrared absorptions due to aryl deuterium. G. V. D. TIERS AND J. H. TIERS. Letter in *J. Chem. Phys.*, **20**, 761–2 (*April*, 1952).

Tables are given for the infrared spectra of disubstituted benzenes, one substituent being deuterium, in the 700–900 cm^{-1} region, where the frequencies are in the mean 20 cm^{-1} higher than the ordinary ones, and in the 500–600 cm^{-1} region, where the bands are probably due to out-of-plane bending vibrations.

C. TURNER

535.343–15

5014. Infrared spectra of some alkyl silanes and siloxanes in gaseous, liquid and solid phases. I. ŠIMON AND H. O. MCMAHON. *J. Chem. Phys.*, **20**, 905–6 (*May*, 1952).

Infrared spectra of tetramethylsilane, hexamethylsiloxane and several siloxanes with a different number of substituted ethyl groups have been studied in a wave number interval from 690 to 1400 cm^{-1}. The spectra of methylated compounds have been obtained in gaseous, liquid and solid phases, and splitting of some of the bands on transition from liquid to solid state has been observed. The strong infrared band observed at approximately 1075 cm^{-1} in the spectra of dimeric siloxanes is classified as a bond-stretching vibration of the oxygen bound to two silicons. A.

535.343–15 : 535.375.5

5015. Contribution to the study of the infrared and Raman spectra of light and heavy trifluoroacetic acids. M.-L. JOSIEN, N. FUSON, J. R. LAWSON AND E. A. JONES. *C.R. Acad. Sci.* [*Paris*] **234**, 1163–5 (*March* 10, 1952) *In French.*

Results of spectral studies on CF_3COOH and CF_3COOD in the vapour state and in solution in CCl_4, on the corresponding anhydride and ethyl ester vapours, and on the solid sodium salt are discussed.

G. I. W. LLEWELYN

535.343–15 : 535.375.5

5016. The infrared and Raman spectra of F_2CO, FClCO and Cl_2CO. A. H. NIELSEN, T. G. BURKE, P. J. H. WOLTZ AND E. A. JONES. *J. Chem. Phys.*, **20**, 596–604 (*April*, 1952).

Combines earlier preliminary reports on F_2CO, FClCO and Cl_2CO into a complete report on the Raman and infrared spectra of these molecules. Details of measurement and handling of the samples are given. The fundamental frequencies observed in both Raman effect (liquid) and infrared (gas) and a large number of overtone and combination frequencies observed in the infrared have been identified and are collected in tables. The observed infrared band envelopes are described and compared with the band envelopes predicted on the basis of the molecular models. Resonance between ν_2 and $2\nu_1$ in F_2CO and ν_2 and $\nu_1 + \nu_4$ in FClCO is discussed. A.

535.343–15 : 535.375.5

5017. Infrared and Raman spectra of fluorinated ethanes. IV. The series CH_3–CH_3, CH_3–CH_2F, CH_3–CHF_2, and CH_3–CF_3. D. C. SMITH, R. A. SAUNDERS, J. R. NIELSEN AND E. E. FERGUSON. *J. Chem. Phys.*, **20**, 847–59 (*May*, 1952).

For Pt III, see Abstr 3468 (1952). The infrared spectra of ethyl fluoride and 1,1-difluoroethane vapours were obtained in the region from 2 to 38 μ, and the spectra of the liquids from 2 to 22 μ, with the aid of LiF, NaCl, KBr and KRS-5 prisms. The Raman spectra of both compounds were studied in the liquid phase with a 3-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. Depolarization ratios were determined for the stronger bands. The Raman spectrum of 1,1-difluoroethane was also obtained for the gaseous phase. A complete assignment of fundamental frequencies is proposed for each molecule and used in a detailed interpretation of the spectra and for the calculation of thermodynamic functions over the temperature range 298–600°K and at the boiling point. A.

535.343–15 : 539.132

5018. Use of the relative intensities of infrared absorption bands for the interpretation of spectra. M. LARNAUDIE. *C.R. Acad. Sci.* [*Paris*] **234**, 1440–3 (*March* 31, 1952) *In French.*

Formulae are developed relating intensities to the components of dipole moment (M) and bond length (r). Even without complete data for M and r it is possible to draw some useful conclusions about relative intensities; and it is found necessary to modify some of the assignments of the bands of cyclohexane previously given by the author [Abstr. 3439 (1951)]. G. F. LOTHIAN

535.343–31

5019. Correlation criterion for the vibrational bands of u.v. absorption spectra. G. MILAZZO. Note in *Naturwissenschaften*, **39**, 81–2 (*No.* 4, 1952) *In German.*

The relative change of the vibrational energy between ground and excited states is used to correlate the measured frequencies of excited states to certain known frequencies of the ground state. This can be used with the half-width and the intensities of bands to estimate the stability of excited states. A large relative change means less stability. Data are given for pyrrol and derivatives. C. TURNER

535.343–31

5020. Investigations of atomic and molecular absorption spectra. I. General features. II. Schumann region absorption spectrum of gallium vapour. W. R. S. GARTON. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 268–76 (*April*, 1952).

Previous work on far u.v. atomic absorption spectra is summarized and discussed with particular regard to the phenomenon of auto-ionization. Details are given of a current programme of work on line and band absorption spectra of vaporized elements and hydrides, in which special attention is paid to the vacuum u.v. Results for the Schumann region absorption spectrum of Ga vapour are given. A.

535.343–32

5021. The ultra-violet absorption spectra of GeO, GeS, GeSe and GeTe. G. DRUMMOND AND R. F. BARROW. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 277–87 (*April*, 1952).

New band-systems of GeSe and GeTe were found, and the vibrational analysis of one of them, the E–X system of GeSe, was completed. The corresponding system, E–X, of GeS was considerably extended, and fairly sharp dissociation limits were found for both GeS and GeSe. A satisfactory spectrogram of GeO in absorption was obtained. Values of the electronic and vibrational constants for all the known states of the four molecules are derived. A.

535.343.2

5022. The absorption spectra of single crystals of lead sulphide, selenide and telluride. A. F. GIBSON. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 378–87 (*May*, 1952).

The absorption spectra of single crystals of PbS, PbSe and PbTe have been examined in the temperature range from 20°K to 600°K. The spectra are characterized by a sharp absorption edge which coincides with the long wavelength limit of photoconductivity in each material. At longer wavelengths the absorption coefficient increases slowly with increasing wavelength, as in Ge and Si. A.

535.343.2 : 535.338.334

5023. Width of spectral lines of uranyl salts and its temperature dependence. B. I. STEPANOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1158–63 (*No.* 10, 1951) *In Russian.*

The effect has been studied of various processes of energy transformation and propagation in the crystals of uranyl salts on the width of spectral lines. The redistribution of the energy of oscillations in the crystal lattice has been shown to be of paramount importance, and, consequently, the appearance of the spectrum depends upon the change of state of the crystal taken as a whole. F. LACHMAN

535.343.2–15

5024. Some observations on the infra-red absorption spectra (between 10 and 15 μ) of ionones, irones (methyl-6-ionones) and their derivatives. Y.-R. NAVES AND J. LECOMTE. *C.R. Acad. Sci.* [*Paris*] **234**, 924–6 (*Feb.* 25, 1952) *In French.*

These are very complicated, because of the superposition of spectra from various origins; great care should be taken in taking the maxima as proof of the presence of double bonds, and in using the spectra for qualitative calculations. C. TURNER

535.343.2—15

5025. On the infrared absorption spectra (10 to 15 μ) of semi-carbazones, thiosemicarbazones and dinitro-2·4 phenyl hydrazones of ionones, irones (methyl-6-ionones) and related compounds. Y.-R. NAVES AND J. LECOMTE. *C.R. Acad. Sci.* [*Paris*] **234**, 1148–50 (*March* 10, 1952) *In French.*

The powder method makes it easy to obtain these spectra and to confirm from these crystalline compounds the earlier results found for the liquid ketones (preceding abstract). C. TURNER

535.343.3–15

5026. Transmission of water in the near infrared. L. GENZEL. *Optik*, **9**, 143 (*No.* 3, 1952) *In German.*

Data of Curcio and Petty [Abstr. 5274 (1951)] are used to plot transmissions for thicknesses 0·01–10 cm and wavelengths 0·7–2·5 μ. G. F. LOTHIAN

535.343.32–32

5027. Purification of hydrocarbons for use as solvents in far ultraviolet spectroscopy. W. J. POTTS, JR. *J. Chem. Phys.*, **20**, 809–11 (*May*, 1952).

The ultraviolet transmission of four hydrocarbons, *n*-heptane, isopentane, 3-methylpentane and methylcyclohexane, are shown at various stages of purification. The particular advantages of each as a solvent in far ultraviolet spectroscopy is discussed with emphasis on the remarkable transmission of isopentane when purified. A.

535.343.4 : 536.46

5028. Detection of diatomic radical absorption spectra during combustion. R. G. W. NORRISH, G. PORTER AND B. A. THRUSH. Letter in *Nature* [*Lond.*] **169**, 582–3 (*April* 5, 1952).

Absorption during C_2H_2/O_2 explosions sensitized by NO_2 and initiated by flash photolysis shows 3 systems of CH, the Swan and Mulliken systems of C_2, systems of OH, NH and CN and a band, probably due to C_3, at 4051 Å. Spectra are examined at intervals of 20 μsec. A. G. GAYDON

535.343.4–14

5029. The microwave absorption spectrum of acetone vapor. T. L. WEATHERLY AND D. WILLIAMS. Letter in *J. Chem. Phys.*, **20**, 755 (*April*, 1952).

This has been examined between 18 000 and 30 000 Mc/s. Four strong lines have been found, but not identified. They are probably due to rotational transitions for high *J*-values. C. TURNER

535.343.4–15

5030. The spectra of HCl, NH_3, H_2O, and H_2S from 100 to 700 microns. T. K. MCCUBBIN, JR. *J. Chem. Phys.*, **20**, 668–71 (*April*, 1952).

Reports the pure rotation spectra of HCl, NH_3, H_2O and H_2S in the region of the far i.r. from 100 to 700 microns. Observations were made using an instrument which had a resolving power of from 1 to 2 cm^{-1} in that region of the spectrum. A.

535.343.4–15

5031. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. VIII. The spectra of trideuteromethylacetylene and diacetylene from 1·2 μ to 0·7 μ. A. V. JONES. *J. Chem. Phys.*, **20**, 860–7 (*May*, 1952).

For Pt VII, see Abstr. 2626 (1952). The absorption spectra of CD_3C_2H and diacetylene were

investigated under high resolution (21-ft grating) in the photographic infrared with absorbing paths of up to 27 metre atmospheres obtained by multiple reflections. For CD_3C_2H the $3\nu_1$ and $4\nu_1$ bands were resolved and analysed yielding $B_0(CD_3C_2H) = 0{\cdot}2456_6 \pm 0{\cdot}00020\ cm^{-1}$, and, therefore, for the moment of inertia about an axis perpendicular to the symmetry axis $I_B^{(0)} = 113{\cdot}90_9 \times 10^{-40}\ g\ cm^2$. This result, taken in conjunction with the work of Herzberg, Patat and Verleger on CH_3C_2H, confirms that the C–C bond length is abnormally short in this molecule. The value obtained was $r_{C-C}(CD_3C_2H) = 1{\cdot}467 \pm 0{\cdot}003$ Å. For diacetylene the rotational structure of four parallel bands was analysed yielding $B_0 = 0{\cdot}14641 \pm 0{\cdot}00013\ cm^{-1}$, leading to $I^{(0)} = 191{\cdot}13 \times 10^{-40}\ g\ cm^2$. The structure of the bands shows diacetylene to be a symmetrical linear molecule. By assuming values for the C–H and C≡C bond lengths the length of the C–C single bond was calculated to be $r_{C-C}(C_4H_2) = 1{\cdot}37_5 \pm 0{\cdot}01$ Å. A.

535.343.4–31

5032. The effect of argon and of nitrogen at pressures up to 1000 atm. on the absorption spectrum of nitric oxide in the ultraviolet. J. Granier-Mayence, S. Robin and B. Vodar. *C.R. Acad. Sci.* [*Paris*] **234,** 1357–9 (*March* 24, 1952) *In French.*

The effects of A and of N_2 are qualitatively different: N_2 induces a strong continuous absorption below about 2700 Å, suggesting association between N_2 and NO. R. F. BARROW

535.343.4–31 : 535.372

5033. Spectroscopic studies in the near ultraviolet of the three isomeric dimethylbenzene vapors. I. Absorption and fluorescence spectra of para-dimethylbenzene. C. D. Cooper and M. L. N. Sastri. *J. Chem. Phys.*, **20,** 607–13 (*April*, 1952).

The absorption spectrum of *para*xylene between 2850 and 2350 Å was photographed using a 3-metre grating spectrograph, and the corresponding fluorescence spectrum between 3125 and 2720 Å was photographed with a Bausch and Lomb medium quartz spectrograph. The electronic transition involved is interpreted as $^1A_{1g}$–$^1B_{3u}$ with the 0, 0 band at 36 733 cm^{-1}. Progressions in the fluorescence spectrum involve the totally symmetric vibrations 829 and 1208 cm^{-1}, while progressions of the corresponding frequencies 775 and 1185 cm^{-1} appear in the absorption spectrum. A weak portion of the spectrum is identified with a so-called forbidden transition involving the β_{1g}-component of the $606\varepsilon_g^+$ benzene vibration. This β_{1g}-vibration has a frequency of 648 cm^{-1} in the ground state and of 552 cm^{-1} in the upper state. The α_{1g}-component of the ε_g^+ benzene vibration in *para*xylene has a lower state frequency of 458 cm^{-1} and the upper state value of 367 cm^{-1}. The Tesla luminescence spectrum is interpreted in relation to the fluorescence and absorption spectra. A.

535.345 : 537.311.33

Electrical and optical properties of the sulphides of copper. *See Abstr.* 5116

535.345 : 537.312.5

5034. Transmission and spectral response of lead sulfide and lead telluride. M. A. Clark and R. J. Cashman. Letter in *Phys. Rev.*, **85,** 1043 (*March* 15, 1952).

Experiments suggest that the absorption edges and photoconductivity spectral limits of PbS and PbTe crystals in the 3–4 and 4–5 μ regions respectively are due to impurities and are not characteristic of the matrix crystals. G. F. J. GARLICK

535.377

5035. The duration of excited states of molecules and the fluorescent properties of solutions. M. D. Galanin. *Trudy Fizicheskogo Instituta P.N. Lebedeva Vol. 5. Moscow, Akademii Nauk SSSR* (1950) *pp.* 339–86.

Doctorate thesis presented at the Lebedev Physical Institute.

535.371

5036. The elementary law of decay of crystal phosphors and the phenomenon of cold stimulation. E. I. Adirovich. *Trudy Fizicheskogo Instituta P.N. Lebedeva, Vol. 5. Moscow, Akademii Nauk SSSR* (1950) *pp.* 387–498.

Doctorate thesis presented at the Lebedev Physical Institute.

535.371

5037. The dependence of photoluminescence on the wavelength of the exciting light. M. J. Alentsev. *Trudy Fizicheskogo Instituta P.N. Lebedeva, Vol. 5. Moscow, Akademii Nauk SSSR* (1950) *pp.* 499–531.

Doctorate thesis presented at the Lebedev Physical Institute.

535.371

5038. Elementary processes in the absorption and fluorescence of uranyl compounds. B. I. Stepanov. *Zh. Eksper. Teor. Fiz.*, **21,** 1153–7 (*No.* 10, 1951) *In Russian.*

An attempt at explaining the long fluorescence period of uranyl compounds by assuming that the probability of transition is reduced due to the change in the state of the crystal lattice during optical transition. F. LACHMAN

535.371

5039. The host crystal luminescence of zinc sulfide phosphors. R. H. Bube. *J. Chem. Phys.*, **20,** 708–17 (*April*, 1952).

Effects produced on the host crystal luminescence of ZnS phosphors by increasing the preparation temperature without any additives in the preparation, are compared with effects produced by adding halide in the preparation at a fixed temperature. Both methods of altering the luminescence properties of the phosphors produce qualitatively the same results on (1) intensification of the host crystal emission for excitation by 3650 Å u.v. and by 6 kV cathode rays, and for phosphors of both cubic and hexagonal crystal structure; (2) glow curves after excitation by 3650 Å u.v.; (3) diffuse reflectivity for light in the wavelength range from 3400 to 4200 Å; and (4) the variation of the emission intensity during excitation as a function of operating temperature. Data on the variations, with preparation procedure, of the emission intensity during excitation and of the glow intensity during thermostimulation show that a possible correlation exists between shallow traps and isolated omission defects, and between deep traps and pairs of omission defects; and that a correlation is suggested

etween luminescence centres and particular perurbed (SZn_4) groups in the crystal. At least a part of the intensification caused by adding halide in the preparation must be attributed to a classical "flux" action. A.

535.371

5040. Absolute quantum efficiencies of luminescence of organic molecules in solid solution. E. H. GILMORE, G. E. GIBSON AND D. S. MCCLURE. *J. Chem. Phys.*, **20**, 829–36 (*May*, 1952).

Absolute quantum yield measurements of fluorescence and phosphorescence have been made for a number of organic molecules dissolved in a transparent solid solution (E.P.A.) at 77°K. The quantum efficiencies range from nearly zero for bromobenzene to 0·6 for benzophenone. The measurements are believed to be accurate to about 10%. The nonradiative processes, which account for the quanta not re-emitted, are discussed. If the radiationless processes all originate in the triplet state, the triplet state lifetimes measured in solid solution can be corrected to give the natural lifetime of the triplet (phosphorescent) state. Since one cannot tell *a priori* that this assumption is justified, other experiments are necessary. If the singlet-triplet absorption strength is known, one can tell whether this correction should be applied or not, and infer the origin of the radiationless transition. Finally, a comparison of quantum yields in solid solution with quantum yields in other phases suggests that the mechanism of radiationless transitions, in the absence of concentration quenching and specific solvent and quencher action, is intramolecular potential surface crossing, followed by the transfer of excess vibrational energy to the solvent. A.

535.375.5 : 539.133

Molecular analysis by the method of combination scattering of light. *See Abstr.* 5239

535.375.5.08

5041. On M. M. Sushchinskiĭ's paper "Photoelectric method of investigating Raman spectra." L. G. FEDOROVICH AND YA. S. BOBOVICH. *Zh. Eksper. Teor. Fiz.*, **20**, 1139–41 (*No.* 12, 1950) *In Russian.*

See Abstr. 7161 (1950). Some inaccurate statements are pointed out. The increase of the light-transmitting power of the collimator, attained by reducing the focal distance at a given object-lens diameter and a constant slit width, is made at the expense of the purity of the spectrum. Hence, given identical diameters of the working apertures, identical field-of-sight angles of the object lenses, and identical spectrum purity requirements, a light system with a high light-transmitting power (short focal distance) does not present any gain in the light flux, compared with a long-focal-distance system. The authors give preference to wider and higher slits combined with long-focal-distance optics. F. LACHMAN

535.375.5.08

5042. Reply to the letter of L. G. Fedorovich and Ya. S. Bobovich in connection with M. M. Sushchinskiĭ's paper. M. M. SUSHCHINSKIĬ. *Zh. Eksper. Teor. Fiz.*, **20**, 1141–2 (*No.* 12, 1950) *In Russian.*

See preceding abstract. The author believes that the manufacture of very wide and very high slits compatible with long-focal-distance optics in the investigation of Raman spectra presents great technical difficulties; for a normal slit height (15–20 mm), a collimator with a relative aperture 1 : 2·5 is required (e.g., achromatic lens, diam. 50 mm, focal distance 120 mm). F. LACHMAN

535.39

5043. On the optical properties of multiple thin films with a finite number of layers. N. CABRERA. *C.R. Acad. Sci.* [*Paris*] **234**, 1146–8 (*March* 10, 1952) *In French.*

A simple method of calibrating the optical properties of multiple layers is presented. Formulae are derived for obtaining transmissivities, reflectivities and phase change in terms of refractive indices and number of layers. S. TOLANSKY

535.39

5044. The spectral reflection characteristics of a smoked magnesium oxide surface. G. W. GORDON-SMITH. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 275–80 (*April*, 1952).

Describes an absolute determination of the spectral luminance factors of a flat smoked MgO surface, in the wavelength range 0·4–0·72 micron, for normal incidence and 45° view. The results give an almost constant luminance factor of 1·005 over the middle of this range, with an increase to about 1·01 at the ends of the spectrum. The selectivity of a similar oxide coating on the interior of a small spherical integrator was also studied by a comparison with the flat surface. In these conditions the reflection factor was found to be 0·975 in the middle of the spectrum, falling to 0·962 at 0·4 micron and 0·972 at 0·72 micron. The coatings were fresh, of thickness just over 1 mm, and made from the smoke of burning Mg ribbon. A photoelectric method was used, and problems connected with the linearity of the photocell characteristic and with the spectral transmission of the monochromator used were examined and are discussed. A.

535.39

5045. Optical characteristics of iron oxide layers obtained by evaporation. L. HOLLAND, C. MOUTOU AND K. HACKING. *Rev. Opt.* (*Théor. Instrum.*) **31**, 209–17 (*May*, 1952) *In French.*

Experiments have been made on the vacuum evaporation of iron oxide to form light absorbing layers, but reduction of the oxide at the low pressures normally used caused an increase in the reflectivity of the films and a change in the colour of the transmitted light. This could be partly or totally overcome by (1) evaporating at a higher residual gas pressure ($\simeq 1\ \mu$); (2) subsequent baking of the film in air; or (3) evaporating mixtures of Fe_2O_3 and transparent oxides. With some mixtures a decrease in the refractive index, and in the reflectivity of the film can be obtained. The reflectivity can be further reduced at the film-air surface by depositing an anti-reflection film of MgF_2. The combination of evaporated films produced have the useful characteristics of low reflectivity and high absorption necessary for tinting ophthalmic lenses. A.

535.41

5046. The interference of thin films and the estimation of their thickness. G. C. MÖNCH. *Optik*, **9**, 75–83 (*No.* 2, 1952) *In German.*

A rapid estimation of the thickness of thin films

from interference colours is described. A simple interferometric system involving slits permits the approximate thickness to be derived from the table of interference colours given. The table is calibrated by means of altering the angle of inclination of the light on the thin film. Interference colours are given for films of thickness from 0–900 Å. There is a good deal of objective judgment required in estimating the colours. S. TOLANSKY

535.41

5047. The boundary of total reflection. II. Strict wave-optical calculation [153–60] H. MAECKER; **III. Experimental proof** [161–6] G. LEHMANN AND H. MAECKER. *Ann. Phys.* [*Lpz.*] **10,** 153–66 (*No.* 3); Errata, 316 (*No.* 4–5, 1952) *In German.*

For Pt. I, see Abstr. 4207 (1952). The intensity distribution in the neighbourhood of the boundary of total reflection is calculated by wave optics in a special case. The distribution is found to give a steady change from partial to total reflection unlike the results from geometric optics, described in Pt. I, which show a discontinuity. The wave-optical result is confirmed by practical measurements in Pt III.

R. W. FISH

535.41

5048. Theoretical study of the interference filter. D. C. FRAU. *Rev. Opt.* (*Théor. Instrum.*) **31,** 161–9 (*April*, 1952) *In French.*

The solution is given of the problem of the propagation of a plane monochromatic light wave through an interference filter consisting in a periodic system of any number m of double layers with indices n_1 and n_2 and thicknesses d_1 and d_2 without taking account of absorption. The transmitted intensity (when $n_1d_1 = n_2d_2$ for normal incidence) is expressed as a function of wavelength. By superposition of two of these filters, one can obtain a practically monochromatic filter of high transmittance. A.

535.417

5049. Autocompensated interferometry for measuring the phase change introduced by reflection at an angle on to a thin film. M. CAGNET. *C.R. Acad. Sci.* [*Paris*] **234,** 1143–4 (*March* 10, 1952) *In French.*

The thin film studied partially covers a mirror at which a beam is reflected after traversing the first film and having traversed the second film of a Fabry–Perot interferometer. The fringes of super-position obtained by the double traversal of the system are exactly compensated. Their examination permits determination of the phase change introduced by the thin film. The angle of incidence is immaterial. The optical system is described. The parallel beam of light passes through a Fabry–Perot interferometer after reflection from the mirror, is autocollimated, and returns. Either white light or broadly monochromatic light can be used. The phase change produces a fringe shift. Adjustment is simple.

S. TOLANSKY

535.42

5050. A diffraction phenomenon in the image of two luminous points in coherent light. A. ARNULF, O. DUPUY AND F. FLAMANT. *C.R. Acad. Sci.* [*Paris*] **234,** 1273–5 (*March* 17, 1952) *In French.*

Two pin-holes, whose separation can be varied, are illuminated by coherent light from a third small hole. The eye-pupil is made small, 0·16 mm. The diffraction images of the pin-holes are observed to differ when the pupil is centred on a dark or a bright diffraction band. The limits of resolution for the two cases are found. R. W. FISH

535.42 : 535.317.1

5051. On the foundation of the scalar diffraction theory of optical imaging. O. THEIMER, G. D. WASSERMANN AND E. WOLF. *Proc. Roy. Soc. A,* **212,** 426–37 (*May* 7, 1952).

The relationship between the rigorous vector theory and the approximate scalar theory is investigated and the usual procedure of calculating the intensity in optical images from a single scalar wave-function is justified. Unlike the earlier discussion of Picht (1925) the present analysis takes fully into account the polarization and amplitude properties which an actual light source and the optical instrument impose upon the radiation field. In the calculations of diffraction images the effect of the non-monochromatic nature of natural light is usually disregarded. An estimate is given for the maximum wavelength spread of the source which will give rise to a diffraction pattern that may be calculated from the single monochromatic wave-function of the scalar theory. One of the main reasons for the validity of the scalar theory for a wide class of optical instruments is found to be the fact that each monochromatic component of the spectrum gives rise to **E** and **H** fields with the property that at any particular instant of time they are nearly constant over each of the geometrical wave-fronts which are not too close to the source of the image region. A.

535.421

5052. Externally operated device for multiple exposures in a diffraction grating at grazing incidence under vacuum. N. ASTOIN, B. VODAR AND J. MARTIN. Letter in *J. Phys. Radium,* **13,** 108–9 (*Feb.*, 1952) *In French.*

For a grazing incidence of rays in a curved diffraction grating no satisfactory devices allowing multiple exposures appear to be available. A screen, shutter and winding mechanism are described which enable 8 exposures of 1·5 mm height and 0·5 mm apart to be made on the same film. G. WITTENBERG

535.421

5053. Theoretical resolving power of diffraction gratings. D. H. RANK. Letter in *J. Opt. Soc. Amer.,* **42,** 279–80 (*April*, 1952).

An experimental test is carried through to see which of the two conflicting criteria for resolution, namely the Abbe and the Rayleigh, is experimentally the best. The data show that the Rayleigh criterion is too stringent even with the worst type of photographic plates. S. TOLANSKY

535.421

5054. Homometric diffraction gratings. L. BRU, M. CUBERO AND J. GARRIDO. *Proc. Phys. Soc.* [*Lond.*] *B,* **65,** 255–6 (*April*, 1952).

Diffraction by homometric gratings is examined by the "fly's eye" device. The patterns obtained confirm the theoretical conclusions. A.

535.421

5055. Phase contrast measurements of the ruling structure of optical gratings. I. E. INGELSTAM AND C. DJURLE. *Ark. Fys.*, **4**, 423–39 (*Paper* 27, 1952).

The phase mirror system of obtaining phase contrast allows the light in the main spectral line from a grating to be separated from that due to the structure of the grating, i.e. the Rowlands "ghosts" adhering to the main spectral line. The apparatus is described in detail and the requirements for the phase mirror given. Measurements on some gratings are illustrated and their structure found by analysis.

R. W. FISH

535.43 : 548.7

Molecular scattering of light in crystals. *See Abstr.* 5435

535.434

5056. The measurement of lightscattering intensities according to Brice. W. F. H. M. MOMMAERTS. *J. Coll. Sci.*, **7**, 71–9 (*Feb.*, 1952).

A number of technical details of the measurement of light scattering intensities is discussed. The use of a quarter wave plate instead of an opal glass depolarizer in photoelectric measurements is proposed. A study is made of some light scattering characteristics of the colloidal silica, "Ludox." This system is shown to have negligible scattering dissymmetry and low depolarization (as far as not caused by secondary scattering). Turbidity values have been determined by scattering measurements according to Brice *et al.* [Abstr. 1777 (1951)], and by transmittance measurements. The values obtained by these two measurements are in agreement. The validity of the Brice system of scattering measurements has hereby been confirmed. A.

535.551 : 532.52

5057. Flow birefringence in polydisperse systems of rod-like molecules having a Montroll–Simha distribution. M. GOLDSTEIN. *J. Chem. Phys.*, **20**, 677–81 (*April*, 1952).

Values of the quantities measured in flow birefringence experiments (extinction angle χ and optical factor F) are calculated for polydisperse systems of rigid rod-like molecules, where the polydispersity is assumed to arise from random degradation of a system of molecules all having the same initial length. The recent calculations of Scheraga, Edsall and Gadd, and the distribution function of Montroll and Simha are used. A number of simplifying assumptions are made, and their effect on the results is discussed. A.

535.551.08

5058. Design and performance of a photoelectric circuit for measurement of streaming birefringence and dichroism. D. ZUCKER, J. F. FOSTER AND G. H. MILLER. *J. Phys. Chem.*, **56**, 166–70 (*Feb.*, 1952).

This circuit permits the measurement of the positions of both minimum and maximum light absorption in dilute (less than 0·002%) solutions of amylose–iodine complex under conditions where direct visual measurement of the orientation position is impossible. In the case of streaming birefringence the system shows some slight advantages over visual observation under conditions of very low degrees of birefringence. A.

535.56 : 541.65 : 539.133

The absolute configuration of optically active molecules. *See Abstr.* 5240

535.7 : 612.84

Physiological optics. *See Abstr.* 5477–81

535.8

5059. Sir Charles Parsons and optical engineering. F. TWYMAN. *Parsons Memorial Lecture for* 1951. *London, The Physical Society* (1951) 14 *pp.*, 6 *plates.*

535.822.9

5060. The contrast effect of thick objects in a phase microscope. A. FREY-WYSSLING. *Naturwissenschaften*, **39**, 145–6 (*No.* 7, 1952) *In German.*

The classical theory of phase contrast requires only small phase differences between objects and their surrounding medium if good contrast is to be obtained. Good contrast may, however, be obtained with cylindrical or spherical objects with much larger phase differences. Photographs illustrate the effect.

R. W. FISH

535.822.9 : 535.41

5061. Interference microscopy and mass determination. H. G. DAVIES AND M. H. F. WILKINS. Letter in *Nature* [*Lond.*] **169**, 541 (*March* 29, 1952).

Describes the application of cell interferometry to the determination of approximate dry weights of cells and cell constituents. See also Abstr. 3523 (1952).

535.822.9 : 535.41

5062. Double refraction interference microscope with annular source. M. FRANÇON. *Rev. Opt.* (*Théor. Instrum.*) **31**, 170–6 (*April*, 1952) *In French.*

An interference microscope using double refraction is developed for observing transparent objects. It is based on the presentation of phenomena in a colour where the eye is particularly sensitive to changes in hue. The interfering beams are produced by a lamina of uniaxial crystal, and there are no false fringes as the diffracted beam is not obstructed anywhere. The sensitivity is equal to that of the phase-contrast microscope without its having the drawbacks due to the presence of the phase plate. A.

535.822.9 : 621.385.832 : 621.389

5063. The flying-spot microscope. F. ROBERTS AND J. Z. YOUNG. *Instn Elect. Engrs Paper* 1348, 11 *pp.* [*Early Proof Issue*] [*Television Convention*, 1952].

A c.r.t. providing a television raster of high brilliance and short time-constant is placed in front of the eyepiece of a microscope. The objective produces a minute spot of light that scans the preparation under examination. The amount of light transmitted is determined by the density of the specimen, and the transmitted light is picked up by a multiplier photocell, the output of which is used to modulate a display c.r.t. the raster of which is locked to the scanning raster. The output of the photo-multiplier is also fed via amplitude and time-discriminating circuits to a high-speed counter. Pictures superior to those of a normal optical microscope in size, brightness, contrast and resolution of low contrast materials are obtained. In the case of a field containing discrete particles such as dust, blood, chemical particles, etc., the particles are automatically counted and sized. Applications to clinical medicine, computers, nuclear physics and chemical engineering are described. A.

HEAT 536

536.1

5064. Analysis of the conceptions of temperature and quantity of heat. H. NIEHRS. *Nachr. Wiss. Göttingen, Math-phys. Kl. IIa*, 28 *pp.* (*No.* 1, 1951) *In German.*

A consideration of the logical approach to the establishment of physical entities is followed by detailed discussion of temperature and quantity of heat. Thermal insulation and equilibrium are fundamental ideas in the first of these, whilst the method of mixtures is essential to the second. E. H. DOCK

536.2.01

5065. A problem in heat conduction and its solution. D. RICE. *Amer. J. Phys.*, **20**, 263–6 (*May*, 1952).

Gives a mathematical solution of a standard problem in one-dimensional heat conduction. It is intended to clarify the steps involved in solving certain boundary-value problems. Fourier series and integrals are involved, and the use of the probability integral is necessary for the final solution. Graphs of the original and final conditions are drawn to scale. A.

536.21

5066. Heat conduction along an exponential bar. J. W. MILES. Letter in *J. Appl. Phys.*, **23**, 372 (*March*, 1952).

A solution, for $f(x, 0) = 0, f(0, t) = 1, f(\infty, t) = 0$, is given of the equation $(e^{\alpha x} f_x)x = e^{\alpha x} f_t$, $f = f(x, t)$, representing one-dimensional diffusion, such as heat conduction along a tube of exponentially varying cross-section. W. C. MOSS

536.24

5067. Heat exchange in a solid-in-gas suspension. G. N. KHUDYAKOV AND Z. F. CHUKHANOV. *Dokl. Akad. Nauk SSSR*, **80**, 747–50 (*No.* 5, 1951) *In Russian.*

Describes an experimental investigation on the heat exchange between cold quartz sand (average grain diameter range 75–2 310 μ) and hot air, in direct downward flow. The results obtained, as well as those of Lyakhovskiĭ [free fall in air (1940)] and of Chukhanov and Nikolaev [falling layer (1951)] are represented in a graph where Nu[sselt] numbers are plotted against Re[ynolds] numbers. All experimental points lie round the line $\mathrm{Nu} = 0{\cdot}2\,\mathrm{Re}^{0{\cdot}83}$ agreeing with the assumption of a very small laminar boundary layer. F. LACHMAN

536.42

5068. Theory of phase transitions. I. Z. FISHER. *Zh. Eksper. Teor. Fiz.*, **21**, 942–4 (*No.* 8, 1951) *In Russian.*

Discusses recent theories of phase transitions developed by Soviet authors. Results so far obtained cannot justify the hope of developing an exact theory of the phase transitions of the first kind by the method of branching the solutions of non-linear integral equations. The transitions are expected to be found as discontinuities in the spectrum of values of the volume parameter. This requirement is satisfied in the theory of Bogolyubov (1946) for the liquid-gas transitions. F. LACHMAN

536.421.1 : 532.6

5069. Capillary phenomena on contact melting of crystals. D. D. SARATOVKIN AND P. A. SAVINTSEV. *Dokl. Akad. Nauk SSSR*, **80**, 631–3 (*No.* 4, 1951) *In Russian.*

The mechanism of melting of two different substances in contact at a temperature above the m.pt of their eutectic was examined microscopically. Pairs of crystals used were Bi–Pb, Bi–Sn, Pb–Sb and *o*-nitrophenol–α–naphthylamine. At the point of contact of the crystals eutectic liquid at the eutectic temperature forms and spreads over the surfaces of the crystals, being heated to the temperature of the latter. It is then capable of dissolving more of either component and does so until the crystals are no longer in contact. Cracks in the solids help the spreading of the liquid and cause the crystals to be eroded from the inside. A. L. MACKAY

536.422

5070. Theory of evaporation rate of solids. K. NEUMANN. Note in *Naturwissenschaften*, **39**, 107–8 (*No.* 5, 1952) *In German.*

A general derivation, based on the methods of "classical" reaction kinetics, of the theory of Spingler [Abstr. 2562 (1943)]. F. LACHMAN

536.423.4

5071. Note on the flow of vapor between liquid surfaces. M. S. PLESSET. *J. Chem. Phys.*, **20**, 790–4 (*May*, 1952).

The mass flow of vapour from a liquid surface at temperature T_0 to another surface of the same liquid at temperature $T_1 (T_1 < T_0)$ may be very readily determined in the case of one-dimensional flow from the conservation relations for mass and momentum. These relations involve both the coefficient of evaporation and the coefficient of condensation. It is therefore possible to determine the condensation coefficient which has heretofore not been accessible to measurement. A new method for determining the evaporation coefficient is also made available. The temperature of the vapour between the liquid surfaces may also be found when viscous effects in the vapour flow are neglected. A.

536.423.4

5072. The theory of the condensation of supersaturated ion-free vapour. F. J. M. FARLEY. *Proc. Roy. Soc. A*, **212**, 530–42 (*May* 22, 1952).

The thermodynamic theory of the condensation of supersaturated vapours at the cloud limit is given in detail. A calculation of the rate of drop formation in water vapour in a typical expansion chamber gives reasonable agreement with experiment. The predictions of the theory as to the dependence of the cloud limit on temperature, and on the nature of the condensing vapour, appear to be correct, although the experimental data here are incomplete. A.

536.46 : 541.126

5073. A contribution to the kinetic study of combustion and ignition reactions. The rate of propagation of flames. A. VAN TIGGELEN. *Mem. Acad. Roy. Belg. Cl. Sci.*, **27**, 27 *pp.* (*No.* 1, 1952) *In French.*

A theory of flame propagation is developed upon the postulate that a chain-reaction proceeding in the

ame is the dominant factor determining the flame peed; a steady state is attained when the concentration of chain-carriers in the flame zone remains const. t is shown that if α is the probability of a chain-branching collision, and β the probability of chain-breaking, then the flame velocity V is given by $V/4 = [2RT(\alpha-\beta)/3M]^{\frac{1}{2}}$ where R is the gas-const., the mean temp. in the pre-flame region, and M the mol. wt. of the chain-propagating centres. It was found that flame velocities in a wide range of H_2–O_2–N_2 mixtures, calculated by this method were always approx. 50% higher than experimental values; this uniform error may be partly due to an approximation made in averaging the velocity distribution of the active centres, but it is also known that there may be a similar error in the experimental results. It is pointed out that the factor mainly controlling the flame speed is, on this theory, the energy of activation of the chain-branching reaction, and it is suggested that the similarity of flame-speeds over a wide range of mixtures of air with aliphatic hydrocarbons lends support to this view. A. SCHOFIELD

536.461

5074. On the stabilization of a deflagration wave in a divergent conduit. M. BARRÈRE. *C.R. Acad. Sci. [Paris]* **234,** 1347–9 (*March* 24, 1952) *In French.*

The addition of a slowly-divergent exit cone to a conventional cylindrical burner has been found to stabilize a flame formed at the exit from the diverging channel or in the channel itself. By varying the rate of gas flow, the divergence of the channel, and the gas composition, the flame can be made to take up a variety of shapes ranging from the normal conical to nearly plane. By this technique, it is possible to separate and to stabilize the outer and the inner combustion zones of a flame, thus facilitating spectrographic examination. A. SCHOFIELD

536.48

5075. Anomalous thermal conductivity of pure metals at low temperatures. J. K. HULM. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65,** 227–8 (*March*, 1952).

The discrepancy for the relatively "ideal" metal sodium, between the theoretical values of its low temperature thermal and electrical conductivities and those recently measured by Berman and Macdonald [Abstr. 944 (1952)] is essentially of the same type as that already known for many other more complex metals such as Sn, Pb, W, Fe and Pt and therefore suggests a breakdown in the theory of a rather fundamental nature. A. D. LE CLAIRE

536.48

5076. Theories of helium II. R. B. DINGLE. *Adv. Phys.*, **1,** 111–68 (*April*, 1952).

Review article with extensive references. Chief contents: survey of salient experimental features; discussion of the relation between zero-point energy and persistence of the liquid state down to absolute zero; theories of the origin of the λ-point, particularly those based on order-disorder transitions, Bose–Einstein condensation, Landau's quantum hydrodynamics and Green's theory of quantum liquids; formulation of the hydrodynamics of He II for small velocities and discussion of the basic assumptions involved; formulation of hydrodynamics for large velocities (partly original work not previously published); discussion of the effects of irreversible processes on the hydrodynamics of He II; and a survey of theories of the He film. R. B. DINGLE

536.48

5077. Properties of helium three at low temperatures. J. G. DAUNT. *Adv. Phys.*, **1,** 209–68 (*April*, 1952).

Review article with extensive references. Chief contents: survey of the natural sources of He^3, and methods of enrichment and production; observed properties of solutions of He^3 in He^4, especially effect of admixture of He^3 on the λ-point of He^4, isotopic osmosis, the distribution coefficient between solution and saturated vapour, and effect of He^3 admixture on second sound; observed properties of pure liquid He^3, especially density, vapour pressure and lack of superfluidity; melting curve of He^3; and a detailed discussion of theories of solutions of He^3 in He^4, and of pure liquid and solid He^3. R. B. DINGLE

536.48

5078. The solubility of He^3 in liquid He^4. J. G. DAUNT AND C. V. HEER. *Phys. Rev.*, **86,** 205–8 (*April* 15, 1952).

Measurements are reported of the distribution coefficient for He^3 between solutions of He^3 in liquid He^4 and their saturated vapours in the temperature range 1·4°K to 2·6°K. The results obtained below the λ-temperature give values for C_V/C_L higher than those calculable for perfect classical solutions, but in good agreement with the theory previously proposed by Heer and Daunt. Above 2·18°K, the λ-temperature for pure liquid He^4, the measured C_V/C_L also appears greater than that for perfect classical solutions, as was predicted by Heer and Daunt. A comparison with the theory of de Boer and Gorter is also given. A.

536.48

5079. Critical velocity of superflow in liquid helium II. H. M. FRIED AND P. R. ZILSEL. Letter in *Phys. Rev.*, **85,** 1044–5 (*March* 15, 1952).

The expression $v_s d < 4\eta_n/(\rho - \frac{1}{4}\rho_n) \simeq 5\times10^{-4}$ cm²/sec is derived from a nonlinear term in Zilsel's hydrodynamics [Abstr. 8710 (1950)]. H. LONDON

536.48

5080. Wave propagation and flow in liquid helium II. K. R. ATKINS. *Adv. Phys.*, **1,** 169–208 (*April*, 1952).

Review article. Assuming that the damping forces acting on the normal fluid of He II can be described by a viscosity term, a mutual friction F_{sn} depending on the relative velocities of normal and superfluid, and a term F_n depending only on the velocity of normal fluid, and those acting on the superfluid by the mutual friction term $-F_{sn}$ together with a term F_s depending only on the velocity of superfluid, the author reviews the various flow phenomena of He II to discover the limiting force operative in each case. Experimental data on the velocity, and attenuation of first and second sound in He II are discussed in connection with Landau and Khalatnikov's theory of viscosity [Abstr. 940–1, 6451 (1950)]. R. B. DINGLE

536.483

5081. Vacuum-powder insulation for low temperatures. L. L. KATAN. *Vacuum*, **1,** 191–202 (*July*, 1951).

A historical account is given of the development of the method of insulation by fine powders combined

with low pressures. The general theory shows that reduction of conductivity begins at the transitional pressure, when the molecular mean free path is of the order of the interstitial distance. Conductivity measurements by the rate of evaporation of liquid O_2 from an insulated vessel confirmed this. Slag wool, B.M.C. powder, Brelite and silica aerogel were used at pressures between atmospheric and 0·001 mm Hg. Applications are to improve insulation, reduce its thickness, allow greater leakage rates, or to insulate liquid gas transfer tubes. W. C. MOSS

536.521 : 535.232

5082. A visual and a photoelectric portable colour temperature meter. H. G. W. HARDING. *J. Sci. Instrum.*, **29**, 145–8 (*May*, 1952).

The construction and calibration of the two colour-temperature meters are described. The range of the visual meter is from 2000°K to infinite temperature and that of the photoelectric one from 1800–10 000°K. The accuracy of both instruments is estimated to be about 100°K at 3000°K and 1000°K at 10 000°K. A.

536.63 : 536.44

5083. On the ratio, γ, of the specific heats of carbon dioxide near the critical region. J. NOURY. *C.R. Acad. Sci.* [*Paris*] **234**, 1036–8 (*March* 3, 1952) *In French.*

The value of γ for CO_2 is calculated from measurements of the velocity of sound at 960 kc/s and 260 kc/s, and the experimental equation of state of Michels, as a function of pressure. The values from ultrasonic measurements are higher than those deduced by Michels and his collaborators from compressibility data. Also for the same pressure and temperature a higher value of γ results from the measurements of higher frequency. These results are in agreement with the phenomena of dispersion studied by other workers, whilst the fact that for the same pressure the velocity increases with frequency confirms the persistence of dispersion at relatively high pressures. F. E. HOARE

536.631

5084. The heat capacities of uranium, uranium trioxide, and uranium dioxide from 15°K to 300°K. W. M. JONES, J. GORDON AND E. A. LONG. *J. Chem. Phys.*, **20**, 695–9 (*April*, 1952).

Heat capacity measurements have been made over the temperature range 15–300°K for uranium metal, uranium trioxide, and uranium dioxide. A maximum was observed at 28·7°K in the heat capacity curve of UO_2 which is probably the result of the changing population of the magnetic quadrivalent uranium ions among their available energy states. The entropies of these substances at 298·16°K are 12·03, 23·57 and 18·63 cal deg^{-1} mole^{-1}, respectively. The free energies of formation of UO_3 and UO_2 are $-273·1 \pm 3$ and $-246·6 \pm 0·6$ kcal mole^{-1}, respectively. A.

536.631

5085. Measurement of the specific heat at room temperature of copper in the form of wire by electrical heating. A. R. INGLES. *Amer. J. Phys.*, **20**, 289–92 (*May*, 1952).

The experiment described was devised for the purpose of stimulating the interest of advanced students in methods already employed in accredited research; it also offers an exercise in the correction for heat losses by radiation and convection and indicates a method of minimizing conduction loss. A.

536.631 : 541.133

5086. Specific heat of synthetic high polymers. I. A study of polyethylene including a statistical theory of crystallite length. M. DOLE, W. P. HETTINGER, JR., N. R. LARSON AND J. A. WETHINGTON, JR. *J. Chem. Phys.*, **20**, 781–9 (*May*, 1952).

Data are given for the specific heat of granular, sheet, annealed and drawn samples of polyethylene from −20° to 200°C. From the data, changes in enthalpy and entropy between these temperatures have been calculated and an estimate made of the free energy of the cold drawing process. The percentage of crystallinity calculated from the enthalpy value is given as a function of temperature and compared with similar estimates from X-ray and density measurements. The applicability of Flory's important theory of crystallization in high polymers to the polyethylene data is studied. A new statistical treatment of crystallite length distribution similar to, but more mathematically exact than Flory's, is also presented. Curves based partly on theory and partly on experiment are given for the weight distribution of crystallites as a function of chain length for annealed and drawn Polythene. A.

536.66

5087. The determination of heats of mixing. G. H. CHEESMAN AND A. M. B. WHITAKER. *Proc. Roy. Soc. A*, **212**, 406–25 (*May* 7, 1952).

A calorimeter has been designed for measuring the heats of mixing of binary liquid systems, which eliminates the need to correct for changes in the composition of the vapour phase on mixing. Improved accuracy has thus been obtained. Heats of mixing have been measured for the 3 binary systems formed from the 3 components carbon tetrachloride, chloroform and methylene chloride, and also for the systems benzene + carbon tetrachloride and benzene + ethylene dichloride. Reports that the last system is ideal have been disproved. A.

THERMODYNAMICS 536.7/.8

536.7

5088. Transformation properties of the Onsager relations. R. O. DAVIES. Letter in *Physica*, **18**, 182 (*March*, 1952).

The condition for the reciprocal relations to be independent of a linear transformation of forces and fluxes. R. O. DAVIES

536.7

5089. Thermodynamic properties of the fluorine atom and molecule and of hydrogen fluoride to 5000°K. L. G. COLE, M. FARBER AND G. W. ELVERUM, JR. *J. Chem. Phys.*, **20**, 586–90 (*April*, 1952).

The evaluation of the thermodynamic functions C_p, S^0, $-(F^0 - E_0^0)/T$, and $(H^0 - E_0^0)/T$ of the fluorine atom and molecule and of hydrogen fluoride from 100°K to 5000°K have been made by statistical calculations from available spectral constants for the

atom and for HF; for F the constants have been derived or estimated from the Raman shift in gaseous ..., the equilibrium internuclear distance from electron diffraction measurements, and the heat of dissociation. These results have been combined with the thermodynamic functions of hydrogen to evaluate the heats and free energies of dissociation and dissociation constants for the equilibria $F_2 \rightleftharpoons 2F$, $HF \rightleftharpoons \frac{1}{2}H_2 + \frac{1}{2}F_2$ and $HF \rightleftharpoons H + F$. A.

536.7 : 541.183

On basic concepts in surface thermodynamics. *See Abstr.* 5402

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

5090. On the effective mass of electrons for models with one conducting zone. A. R. REGEL. *Zh. Eksper. Teor. Fiz.*, **21**, 845–50 (*No.* 7, 1951) *In Russian.*

Simple formulae and tables are given for the calculation of the effective mass m^* in terms of the chemical potential γ. It is shown that for metals $n^*/(\text{electron mass}) \simeq 1 \pm 0{\cdot}4$. A decrease of m^* is noted for homopolar or metallic bonds when the number of carriers per cm³ decreases below 10^{20}.

W. J. SWIATECKI

537.12

5091. On Dirac's new classical theory of electrons. G. HÖHLER. *Ann. Phys.* [*Lpz.*] **10**, 196–200 (*No.* 3, 1952) *In German.*

It is shown that Dirac's classical theory of electrons [Abstr. 981 (1952)] appears as a limit case both from the intuitive particle picture and from the intuitive wave picture, and that it is equivalent to the Maxwell–Lorentz theory for continuously distributed charge.

R. H. DALITZ

537.12

5092. A new classical theory of electrons. II. P. A. M. DIRAC. *Proc. Roy. Soc. A*, **212**, 330–9 (*May* 7, 1952).

For Pt I, see Abstr. 981 (1952). An analysis is made of the motion of a stream of electrons obeying Lorentz's equations of motion. It leads to a more general action principle than that of the earlier paper, containing two new field variables. The present theory allows vorticity in the electron stream, while still involving e and m only in the ratio e/m. A Hamiltonian formulation of the equations is deduced. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.212 : 538.12 : 621.3.013

5093. The two-dimensional magnetic or electric field inside a semi-infinite slot terminated by a semi-circular cylinder. N. DAVY AND N. H. LANGTON. *Brit. J. Appl. Phys.*, **3**, 156–8 (*May*, 1952).

The field is investigated inside (*a*) a semi-infinite slot with a semi-circular closed end in a magnetized ferromagnetic body, such as a slotted armature or a polepiece; or (*b*) a hollow electrical conductor of the same shape. Tables of calculated values of the field at important points, and the corresponding graph, are given. A.

537.213

5094. Electrical properties of films of condensed aromatic hydrocarbons on aqueous solutions of inorganic salts. M. GEROVICH, V. SMIRNOVA AND M. TETERINA. *Dokl. Akad. Nauk SSSR*, **81**, 219–22 (*No.* 2, 1951) *In Russian.*

Presents results of a research conducted with phenanthrene, anthracene, 1, 2-benzanthracene and tetracene. The relationships between the area for one molecule and the surface potential (and bi-dimensional pressure in the case of phenanthrene) are given in graphical and tabular form. F. LACHMAN

537.213 : 621.317.727

5095. Potentiometer circuit for measurement of high potential. T. B. RYMER AND K. H. R. WRIGHT. *J. Sci. Instrum.*, **29**, 139–41 (*May*, 1952).

A potentiometer is described for the measurement of d.c. potentials of the order of 50 kV with an accuracy of 0·01%. The effect of leakage current is eliminated partly by the use of a comprehensive system of guard circuits supplied by subsidiary networks connected across the h.t. supply, and partly by the use of a Wheatstone birdge circuit which enables the potentiometer ratio to be measured under operating conditions while the high potential is applied. A.

537.221

5096. Determination of the work functions of Cd, Cu, Sn, Zn, from their contact potentials with regard to Ag. R. HIRSCHBERG AND E. LANGE. Note in *Naturwissenschaften*, **39**, 131 (*No.* 6, 1952) *In German.*

The improved method of Fianda and Lange (1951), consisting in abrading the metal surface in a vacuum, yields a reproducibility within $\pm$ 10 mV and constancy of potential during 30 min after abrasion. The following values have been obtained for electron-exit potentials: Cd, 4·49; Cu, 4·86; Sn, 4·64 and Zn, 4·65 V. F. LACHMAN

537.226 : 539.133

5097. Calculation of polarization and dipole moment from solution data. S. R. PALIT AND B. C. BANERJEE. *Trans Faraday Soc.*, **47**, 1299–1304 (*Dec.*, 1951).

Since polarization is expressed in volume units it is suggested that methods similar to that used in calculating partial molal volume in binary mixtures may be supplied for computing the former. Thus, a theoretically sound method of calculating polarization at infinite dilution and hence the dipole moment either graphically or analytically can be obtained. This method is much simpler in computation than the usual methods and is found to yield reliable results. A.

537.226.08 : 621.392.26 : 621.317.335.3

5098. A new method of measuring the permittivity of liquids at hyperfrequencies. C. BROT AND M. BRUMA. *C.R. Acad. Sci.* [*Paris*] **234**, 1041–3 (*March* 3, 1952) *In French.*

A length of rectangular waveguide has one of its narrow walls in the form of a long piston, enabling

the cut-off wavelength of the guide to be adjusted at will. The required permittivity is obtained (for a low-loss dielectric) as a_0^2/a_1^2, where the a's are the guide breadths at cut-off with air and sample filling respectively. A 1% accuracy is obtainable at 10^{10} c/s.

F. F. ROBERTS (R)

537.226.2

5099. High-voltage polarization in polycrystalline sintered titanium dioxide. S. I. GORELIK AND V. E. TOLSTOĬ. *Zh. Eksper. Teor. Fiz.*, **21**, 833–8 (*No.* 7, 1951) *In Russian.*

Relationship between temperature and electric field of high-voltage polarization, also initial and final electric conductivities, were investigated in TiO_2 with admixtures of CaO and SrO. Deviation from Ohm's law of final values of electric conductivity is due to lack of polarization e.m.f. In the range of fields 1–16 kV/cm initial conductivity follows Ohm's law. Samples have shown the high-voltage polarization to approach external stresses. J. LUKASZEWICZ

537.226.2

5100. Dielectric absorption in solid aliphatic methyl esters. J. S. DRYDEN AND H. K. WELSH. *Aust. J. Sci. Res. A*, **4**, 616–26 (*Dec.*, 1951).

See Abstr. 3977 (1949), 257 (1950). The dielectric absorption in three aliphatic methyl esters, methyl palmitate, methyl stearate and methyl behenate, has been measured over a wide frequency range at temperatures of 25, 2 and −18°C. The measurements reveal that there are two absorptions in these esters, both arising from relaxation mechanisms. Deductions made from the results indicate that one of the absorptions is due to the rotation of the ester molecule from one position of equilibrium in the crystal lattice to another, and that the other absorption arises from rotation of the polar group (which in these molecules is at one end) from one position of relative equilibrium to another. A.

537.226.2

5101. The effect of moisture on the electrical properties of soil. A. COWNIE AND L. S. PALMER. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 295–301 (*April*, 1952).

Measurements of the dielectric constant of soil containing different known percentages of moisture were made at a fixed frequency of 430 Mc/s. The method adopted involved the use of a coaxial transmission line terminated with a sample of the soil under test. The line consisted of a central rod with a concentric tube about 2½ m long. Measurements were made with soil samples containing from 4·1% to 47·7% moisture. The dielectric constant was found to vary from 4·0 to 31·4. The values are shown graphically and compared with those obtained by 9 other authors. The conductivity could not be measured accurately with the method used, but it was estimated to vary from about $1{\cdot}5\times10^9$ e.s.u. with 4% moisture to 4×10^{10} e.s.u. with 50% moisture. A.

537.226.2

5102. Ferroelectricity and antiferroelectricity in ceramic $PbZrO_3$ containing Ba or Sr. G. SHIRANE. *Phys. Rev.*, **86**, 219–27 (*April* 15, 1952).

Phase transitions in solid solutions (Pb–Ba)ZrO_3 and (Pb–Sr)ZrO_3 were studied by dielectric, dilatometric and calorimetric measurements. It is shown that when the Ba concentration in (Pb–Ba)ZrO_3 compositions exceeds a threshold value of about 5%, a ferroelectric intermediate phase begins to appear between the paraelectric and antiferroelectric phases of pure $PbZrO_3$. The temperature range of this intermediate phase increases with the Ba concentration. Though no intermediate phase can be observed in compositions which contain Ba ions with less than this threshold concentration, a forced transition from the antiferroelectric phase to a ferroelectric phase can be caused by the application of a strong electric field at temperatures just below the Curie point. In the (Pb–Sr)ZrO_3 system an intermediate phase can also be observed, but this phase proves to be another antiferroelectric phase and not a ferroelectric one. It is concluded, from these situations, that the antiferroelectric phase in pure $PbZrO_3$ must be very peculiar, the free energy of this phase being closely adjacent to those of a ferroelectric phase as well as another antiferroelectric phase. A.

537.226.2 : 538.22 : 538.566

5103. An optical method for the determination of the complex dielectric constant ϵ and the magnetic permeability μ. H. FALKENHAGEN AND G. KELBG. *Ann. Phys.* [*Lpz.*] **10**, 170–6 (*No.* 3, 1952) *In German.*

A method is given for the determination of the complex dielectric constant and the permeability in the region of the centimetre and millimetre waves. In this system the reflection coefficient and the transmission coefficient of a coplanar plate are determined when a plane e.m. wave is vertically incident upon it. From the knowledge of these coefficients it is shown how to calculate the complex material constants ε and μ. Z. F. WOJNAR

537.226.2 : 538.221

5104. Dielectric constant and permeability of various ferrites in the microwave region. T. OKAMURA, T. FUJIMURA AND M. DATE. Letter in *Phys. Rev.*, **85**, 1041 (*March* 15, 1952).

By means of a rectangular cavity with disk-shaped samples placed at positions of high electric or magnetic field the real and imaginary parts of ε and μ are measured at 6·6-cm wavelength and tabulated for both quenched and annealed Mg, Cu, Co, Ni and Mn ferrites. D. H. WHIFFEN

537.228.1 : 539.32

5105. Elastic and piezoelectric coefficients of lithium sulphate monohydrate. R. BECHMANN. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 375–7 (*May*, 1952).

A new determination has been made of the elastic and piezoelectric coefficients of $Li_2SO_4 . H_2O$ and of their temperature coefficients. A.

537.228.1 : 539.42

Mechanical strength of piezoelectric crystals. *See Abstr.* 5362

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3.08 : 621.317.723

5106. A simple low-drift electrometer. F. M. GLASS. *Nucleonics*, **10**, 36–9 (*Feb.*, 1952).

The instrument described is a simple mains-

perated valve-voltmeter, employing two sub-miniature electrometer triodes in a bridge circuit, as the input stage. The two tubes are a matched pair which have been subjected to an ageing process. The instrument can measure currents down to 10^{-15} A, with ± 1% linearity over full scale. The drift is ±½% of full-scale deflection per hour after the first hour of operation. The instrument is used to drive a 10-mV recorder or can be used alternatively as a null instrument. L. R. SHEPHERD

537.311.31

5107. Electron conductivity in polycrystalline sintered titanium dioxide. S. I. GORELIK. *Zh. Eksper. Teor. Fiz.*, **21**, 826–32 (*No.* 7, 1951) *In Russian.*

Transverse magnetic field decreases electric conductivity in pure sintered TiO_2 and in TiO_2 with admixtures of CaO, SrO, BaO, MgO and $BaTiO_3$. Concentration of CaO and SrO influences electric conductivity of TiO_2. Transverse magnetic field does not change the magnitude of electric conductivity instantaneously to a steady value. Increase in temperature decreases this inertia. Samples showing increased polarization and losses in low-frequency alternating electric field have higher electric conductivity and lower dissociation energy. J. LUKASZEWICZ

537.311.31 : 539.23

5108. Measurements on thin iron films. A. VAN ITTERBEEK, L. DE GREVE AND F. HEREMANS. *Appl. Sci. Res. B*, **2**, 320–4 (*No.* 4, 1952).

Curves are established for the specific resistance as a function of thickness for iron films obtained respectively by sputtering or condensation in vacuum. The curves obtained are completely different. Electron microscope and electron diffraction pictures of the films are given. A.

537.311.31 : 539.234

5109. Electrical properties of very thin films of silver, aluminium and silicon. A. BLANC-LAPIERRE, M. PERROT AND J.-P. DAVID. *C.R. Acad. Sci. [Paris]* **234**, 1133–5 (*March* 10, 1952) *In French.*

Experiments of the kind previously described [Abstr. 7978 (1950), 1047 (1951)] were carried out for Ag, Al and Si films deposited at less than 10^{-6} mm. At high fields (200 V/cm or more) appreciable departures from Ohm's law were observed. C. A. HOGARTH

537.311.31 : 539.4.016

5110. Conductivity of cold-worked metals. D. L. DEXTER. Letter in *Phys. Rev.*, **85**, 936 (*March* 1, 1952).

The calculations of Landauer [Abstr. 5402 (1951)] of the change in electrical conductivity due to an edge-type dislocation are modified and extended, and the effect of the singularity in the assumed scattering potential is considered. M. R. HOPKINS

537.311.32 : 548.7

The state of a conduction electron in an ideal homopolar crystal. *See Abstr.* 5436

537.311.33

5111. On impurity and intrinsic semiconduction of intermetallic compounds. I. E. JUSTI AND G. LAUTZ. *Z. Naturforsch.*, **7a**, 191–200 (*Feb.*, 1952) *In German.*

The system Cd–Sb has been investigated and the following facts have been established: a strong resistance maximum with composition has been found and corresponds to the compound CdSb; the maximum is lowered by the addition of Ag or Ni and increased by the addition of Pd; at the melting point of CdSb (456°C) there is a sudden increase in the electrical conductivity. The authors attempt an interpretation of these results with reference to the Brillouin zones of CdSb. The suggestion is that the available electrons fill exactly the first seven zones, and that there is no overlap into the eighth zone. It is suggested that pure CdSb is therefore an intrinsic semiconductor and that addition of other substances can cause impurity semiconduction. P. T. LANDSBERG

537.311.33

5112. A uni-directional noise generator. G. WLÉRICK. *C.R. Acad. Sci. [Paris]* **234**, 1260–2 (*March* 17, 1952) *In French.*

It is found that the noise generated in certain PbS layers can depend on the direction of the applied voltage. C. A. HOGARTH

537.311.33

5113. The dispersion of permittivity and conductivity of semiconductors. R. E. BURGESS. Letter in *Phys. Rev.*, **86**, 131–2 (*April* 1, 1952).

These quantities are investigated for granular semiconductors and the two-layer model is investigated. The results are in better accord with experimental data than those of Koops' theory [Abstr. 6964 (1951)]. C. A. HOGARTH

537.311.33

5114. Diffusion of donor and acceptor elements into germanium. C. S. FULLER. Letter in *Phys. Rev.*, **86**, 136–7 (*April* 1, 1952).

By determining the positions of *p–n* barriers in Ge specimens of different conductivities when elements such as In and Zn diffuse in, the diffusion constant D, and surface carrier concentration can be calculated. The values of D for In and Zn are $0{\cdot}9\times10^{-12}$ and $2{\cdot}3\times10^{-12}$ (775°C) and $4{\cdot}0\times10^{-12}$ and $1{\cdot}0\times10^{-11}$ cm²/sec (845°C) respectively. C. A. HOGARTH

537.311.33

5115. Measurement of diffusion in semiconductors by a capacitance method. K. B. MCAFEE, W. SHOCKLEY AND M. SPARKS. Letter in *Phys. Rev.*, **86**, 137–8 (*April* 1, 1952).

Measurements of capacitances of *p–n* junctions in Ge before and after heat treatments which cause diffusion and hence changes in the gradient of impurity distribution enable diffusion constants for the introduced impurity, e.g. As, to be determined. For As in gallium containing *p*-type Ge at 800°C a value of between 1×10^{-13} and 5×10^{-12} cm²/sec is obtained and is much smaller than the result of Fuller (preceding abstract). C. A. HOGARTH

537.311.33 : 535.345

5116. Electrical and optical properties of the sulphides of copper. L. EISENMANN. *Ann. Phys. [Lpz.]* **10**, 129–52 (*No.* 3, 1952) *In German.*

The sulphur content of copper sulphide layers was varied continuously and measured by means of a quartz microbalance. X-ray analysis of these layers (up to 300 mμ thick) showed whether CuS, Cu_2S, or a mixture of the two were present. Lines corresponding to the compound Cu_9S_5 were frequently found.

The resistance of the layers down to 14°K and the optical absorption and refractive index in the 0·4 to 3 μ region were measured. Cu_2S, mixtures of Cu_2S and Cu_9S_5, and Cu_9S_5 behave as semiconductors, but as the S content increases beyond this point the conduction properties become more and more metallic until, with CuS, electrical properties similar to those of Hg are observed. Optical absorption in CuS indicates almost entirely free carrier absorption, whereas for Cu_9S_5 and Cu_2S typical semiconductor behaviour is observed. C. A. HOGARTH

537.311.33 : 537.32

5117. On the thermoelectric properties of semiconductors. G. E. PIKUS. Note in *Zh. Eksper. Teor. Fiz.*, **21**, 852–3 (*No.* 7, 1951) *In Russian.*

It is shown that the "Gurevich effect" [an additional thermo e.m.f. associated with temperature gradients] is negligible for semiconductors. W. J. SWIATECKI

537.311.33

5118. Probing the space-charge layer in a *p–n* junction. G. L. PEARSON, W. T. READ AND W. SHOCKLEY. Letter in *Phys. Rev.*, **85**, 1055 (*March* 15, 1952).

The potential distribution is measured for Ge by probing with a W point across 50×10^{-4} cm, and with applied potentials of 20 to 80 V. The potential is proportional to the inverse cube of the capacity and the square of the infrared refractive index is found to equal the dielectric constant at 1000 c/s. The barrier widths are 3·7, 2·9 and $2\cdot4\times10^{-3}$ cm, for applied fields of 85, 45 and 20 V respectively.

C. A. HOGARTH

537.311.33 : 621.314.632

5119. On the deviation from the Ohm's law at the anode surface of the cuprous oxide rectifiers. M. ONO. Note in *J. Phys. Soc. Japan*, **6**, 397 (*Sept.–Oct.*, 1951).

The fact that the capacitance of a Cu_2O rectifier decreases sharply as the bias voltage approaches zero is explained by assuming a non-ohmic resistance in series with the rectifier. This has an appreciable value only for low applied fields. C. A. HOGARTH (R)

537.311.33 : 621.314.7

5120. Double surface lead sulphide transistor. P. C. BANBURY. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 236 (*March*, 1952).

Transistor action is observed in thinly ground and etched PbS crystals, to which contacts are made on opposite sides. The effective range for injected electrons is about 5×10^{-3} cm. C. A. HOGARTH

537.311.33 : 621.317.755 : 621.314.7

5121. Display of transistor characteristics on the cathode-ray oscillograph. G. B. B. CHAPLIN. *J. Sci. Instrum.*, **29**, 142–5 (*May*, 1952).

To facilitate the rapid testing of transistors, an apparatus is described which displays simultaneously on a c.r.t. a family of *n*-type transistor characteristics, the modifications necessary for *p*-type transistors being indicated. Four of these families are available: (I_E against V_c)I_c = parameter, (I_E against V_E)I_c = parameter, (I_c against V_c)I_E = parameter, (I_c against V_E)I_E = parameter and any one of them can be selected by a switch. The accuracy of the display is ±10%. The circuit has been designed with a view to simplicity, low power consumption and economy in valves and components. A.

537.311.35

5122. The electrical conductivity of liquid selenium and selenium–tellurium mixtures. B. LIZELL. *J. Chem. Phys.*, **20**, 672–6 (*April*, 1952).

The electrical conductivity of liquid Se and Se–Te mixtures was studied in detail. Measurements in the temperature range 230° to 500°C from d.c. to 1 Mc/s indicated the conductivities to be frequency-independent at low field strength (< 5 V/cm). For larger fields (5 to 250 V/cm) the conductivity increases and higher d.c. than a.c. values result. Adding increasing amounts of Te to Se produced a continuous rise in conductivity from $1\cdot26\times10^{-4}$ ohm^{-1} cm^{-1} (pure Se) to $2\cdot08\times10^{-1}$ ohm^{-1} cm^{-1} (50·3% Se, 49·7% Te) at 480°C and a decrease in activation energy from 1·14 eV to 0·84 eV. Comparatively good reproducibility was obtained in the measurements. An attempt to study ionic migration in liquid Se by tracer methods has thus far not given satisfactory results. The conductivity values obtained for pure Se are in good agreement with those presented by Henkels but disagree with those of Borelius. The electrical characteristics of liquid Se and Se–Te mixtures indicate that hole conduction as pictured for Se in the solid state cannot be considered as an adequate explanation of the conduction process in these liquids. A complex mixture of conduction by electrons, holes and ions is believed to exist. A.

537.312.5

5123. The photovoltaic effect in natural lead sulphide. R. LAWRANCE. *Aust. J. Sci. Res. A*, **4**, 569–78 (*Dec.*, 1951).

Australian samples of natural lead sulphide have been used as radiation detectors in the near infrared. The nature of the photovoltaic effect has been investigated and the sensitivity of some cells measured. The electrical properties of bulk samples have been measured. The results have been compared with similar measurements given by other authors for thin lead sulphide films, and a close correlation has been established between them. A.

537.312.5 : 535.345

Transmission and spectral response of lead sulfide and lead telluride. *See Abstr.* 5034

537.312.6

5124. Theory of superconductivity. O. KLEIN. Letter in *Nature* [*Lond.*] **169**, 578–9 (*April* 5, 1952).

It is assumed that superconductivity occurs when the indeterminancy of the energy $\Delta\varepsilon$ connected with the life-time of an excitation is larger than the excitation energy ε for small ε and smaller for large ε, and that for $\varepsilon_0 \simeq kT_c$ (T_c critical temperature) $\Delta\varepsilon_0 \simeq \varepsilon_0$. Calculation of $\Delta\varepsilon$ on the basis of the Bloch model gives, however, an increase of $\Delta\varepsilon$ with ε. This is in accord with the objections raised by Drell [Abstr. 8743 (1951)] against the Fröhlich–Bardeen theories, which are also based on the Bloch approach. Assuming, however, that a small fraction of the electron density remains stationary during the vibrations a decrease of $\Delta\varepsilon$ with ε is obtained, giving reasonable values for T_c and the correct mass dependence.

H. LONDON

537.312.62

5125. On the behaviour of superconductors in a high frequency field. V. L. GINZBURG. *Zh. Eksper. Teor. Fiz.*, **21**, 979–91 (*No.* 9, 1951) *In Russian.*

The high frequency resistance and reactance of superconductors are discussed on the basis of the Ginzburg and Landau phenomenological theory (1950). The main new feature is the introduction of a dielectric constant ε_0 (of order 10^8 to 10^{10}) arising from "normal" electrons in bound states. This should cause a frequency dependence of the anomalous dispersion type of the apparent penetration depth as measured at low temperatures and very high frequencies (such that $h\nu \sim kT_c$). The theory predicts also a variation of resistance with frequency even more rapid than the square law variation predicted by the usual two fluid theory (Pippard, 1950). The high frequency behaviour of thin superconducting films and the mechanism of thermal conductivity are also discussed. D. SHOENBERG

537.312.62

5126. The isotope effect in superconductivity. II. Tin and lead. B. SERIN, C. A. REYNOLDS AND C. LOHMAN. *Phys. Rev.*, **86**, 162–4 (*April* 15, 1952).

For Pt I, see Abstr. 1808 (1952). The critical magnetic fields, H, of various isotopic mixtures of Sn and of Pb have been measured as a function of temperature, T. For tin, the critical temperature T_c at zero field, is related to the average mass number, M, by the relation $M^{3\cdot46}T_c = \text{const.}$ The critical magnetic fields, H_0, at absolute zero are proportional to the critical temperatures. The normalized values of critical field, H/H_0, are the same function of the variable T/T_c for all the isotopes. An analytic expression for this function giving the best fit to the experimental data is given. The measurements on Pb were made in the temperature range 1·6°K to 4·2°K. The data clearly indicate that the isotope effect is present in this superconductor. A.

537.312.62

5127. Superconductivity of the isotopes of tin. E. MAXWELL. *Phys. Rev.*, **86**, 235–42 (*April* 15, 1952).

The superconducting transition temperatures of 6 samples of Sn with masses ranging from 113·58 to 123·01 were measured by a magnetic method and found to obey a relation of the form $M^{0\cdot505}T_c = \text{const.}$ The critical field curves for the samples of mass 113·58, 118·05 and 123·01 were determined between 1·4°K and 3·8°K and observed to be geometrically similar to about 1 part in 800. From this it is concluded that the electronic specific heat in the normal state is independent of mass, and that the thermodynamic functions derived from the critical field curves also have the similarity property. A.

537.32

5128. Measurements of thermoelectric power of Cu_2O at high temperatures. H. MÜSER AND H. SCHILLING. Note in *Z. Naturforsch.*, **7a**, 211–12 (*Feb.*, 1952) *In German.*

Experiments were carried out on Cu films 20 μ thick at 900–1000°C, using a 15°C temperature difference between the ends of the specimen. The effect of various gases O_2, N_2 and CO_2, as a function of time was investigated. With O_2 the thermoelectric power Θ increased rapidly to a maximum value of $+700\ \mu$V/°C in a few minutes and then decreased slowly with time. With gas relatively free of O_2, Θ remained small and positive for over an hour, changed sign and increased, and then reversed again and rose to $+600\ \mu$V/°C after more than 2 hours. The nature of the reactions taking place between the gas and metal atoms is briefly considered.

C. A. HOGARTH

537.32

5129. The thermoelectric power of aluminium in thin films. J. SAVORNIN AND G. COUCHET. *C.R. Acad. Sci.* [*Paris*] **234**, 1608–10 (*April* 16, 1952) *In French.*

The thermoelectric couple consisted of a Cu wire and a film of Al vaporized on to a sheet of glass *in vacuo*. The cold junction was at 0°C and the hot junction at temperatures varying from 15°C to 300°C The thermoelectric power was found to be independent of thickness in the range 10 mμ to 1 μ. The value was $4\cdot00 \pm 0\cdot10\ \mu$V/°C at 0°C. P. M. DAVIDSON

537.365 : 534.39 : 541.182

5130. On electrical effects due to sound waves in colloidal suspensions. F. BOOTH AND J. A. ENDERBY. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 321–4 (*May*, 1952).

An expression is given for the potential differences set up in colloidal suspensions of solid particles by the passage of sound waves, which is correct to the first power of the zeta potential of the particles. The question was examined in detail by Enderby [Abstr. 6981 (1951)]. For a certain range of values of relevant parameters it was found necessary to introduce the simplification that the mobilities of the various ionic species in the electrolyte surrounding the colloidal particles were identical. In the present paper it is shown how the potential may be calculated quite generally without this restriction by the use of vector methods. A.

ELECTRIC DISCHARGES 537.52

537.523.3

5131. Formative time lags of positive point corona in air. M. MENES AND L. H. FISHER. Letter in *Phys. Rev.*, **86**, 134 (*April* 1, 1952).

Describes measurements of formative times in point-plane gaps, for overvoltages varying from zero to about 1·5%. At atmospheric pressure the formative time lags were too short to be measured (limit of accuracy 10^{-7} sec). Results at 500 mm Hg are shown graphically; here the formative time, which varied little with overvoltage, was about 10^{-7} sec.

J. D. CRAGGS

537.523.3

5132. The mechanism of the Trichel pulses of short time duration in air. L. B. LOEB. Letter in *Phys. Rev.*, **86**, 256 (*April* 15, 1952).

This note discusses the recent work on negative

point corona in air and provides a tentative explanation of the short ($\sim 10^{-8}$–10^{-7} sec) light pulses recently observed by English. J. D. CRAGGS

537.525

5133. The dynamic characteristics of a low pressure discharge. B. T. BARNES. *Phys. Rev.*, **86**, 351–8 (*May* 1, 1952).

Square-wave modulation of current at a frequency of 167–400 c/s was imposed on a d.c. discharge in a tube containing mercury vapour at a pressure of 6 μ and argon at 3·5 mm (Hg). The intensity of λ2537 and other data were recorded on oscillograms. Each sudden change of the arc current i was accompanied by an instantaneous change in the same direction of the longitudinal voltage gradient E, the electron temperature T_e, the 2537 output and the ion current to the wall. These instantaneous changes were followed by much slower adjustments toward the steady-state values corresponding to the arc current. The time required for a rough adjustment was 0·2–0·5 msec when the current was increased, and 1–3 msec when it was decreased, for ratios of maximum to minimum current ranging from 1·6 to 3·9. When the current was decreased, there was an excess of ions that had to diffuse to the tube wall. When the maximum arc current was 2·75 times the minimum value, the ratio of the electron concentration n_0 measured at the tube axis to that at the inner edge of the wall sheath (n_w) varied by a factor of 3 during each cycle. Some of this variation can be attributed to greater ion production per electron near the axis; some of it may be an artifact, since the wall probe may alter the radial distribution of electrons. The number of electrons N_e per cm of arc was computed from the measured values of electron concentration by assuming that the radial variation follows the Bessel function $J_0(\mu r/a)$, where $J_0(\mu) = n_w/n_0$. The results for the major part of the cycle do not agree with those computed from the mobility equation. Part of the discrepancy can be ascribed to changes of the radial distribution of electrons during a short period when ion production is very high. Two-stage ionization predominates throughout the cycle. Granovsky's approximate solutions of the basic equations for transient states of a low pressure discharge are not applicable to a Hg discharge with a rare-gas pressure of the order of 1 mm (Hg) or more. Since the concentrations of excited atoms are not single-valued functions of T_e, these equations are insoluble. However, step-by-step graphical or tabular solutions might be made for particular cases by use of experimental values of mean free paths and of the probabilities of exciting, ionizing and radiative transitions. Useful relationships between i, E, T_e and N_e can be obtained by combining the mobility and the energy-balance equations for the electrons. The variation in T_e during a transient depends mainly on the range of i/N_e. Instantaneous values of E are roughly proportional to the square root of the power expenditure w_e per electron. Since T_e is the principal factor fixing w_e, E and T_e are closely interdependent. The modulation of radiant energy must decrease continuously with increasing frequency if a d.c. discharge is operated with a fixed amplitude of current modulation. A.

537.525 : 541.14

5134. Study of the Joshi effect in H_2O and D_2C vapor. N. A. RAMAIAH. *J. Phys. Chem.*, **56**, 218–19 (*Feb.*, 1952).

537.525.5 : 537.527.5

5135. The theory of gaseous arcs. I. The fundamental relations for the positive columns. K. S. W. CHAMPION. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 329–44 (*May*, 1952).

It is postulated that the 5 fundamental relations stated by Tonks and Langmuir to be sufficient to describe fully a l.p. pos. column, also apply to h.p. pos. columns. Previously, only 2 of these relations had been applied to h.p. columns. A "natural arc radius" is postulated for l.p. arcs when the boundaries are removed an indefinite distance. Previous theories of l.p. arcs always assumed that the arc completely filled the cross-section of its containing vessel, and thus did not apply to l.p. arcs in large chambers or arcs at intermediate pressures. The theory of l.p. arcs with high electron densities in which ionization by stages is important is developed. It is then shown that by taking recombination into account this theory may be applied to intermediate and h.p. arcs with a high degree of ionization. A first approximation is also obtained for the theory of h.p. arcs in which there is a low degree of ionization. All the theory presented includes the effect of a longitudinal magnetic field, and the no-field conditions are included as a special case. It is found that the effects of a magnetic field predicted by the theory are in agreement with experimental observations. A.

537.525.5 : 537.527.5

5136. The theory of gaseous arcs. II. The energy balance equation for the positive columns. K. S. W. CHAMPION. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 345–56 (*May*, 1952).

The theory of arcs is developed further by investigating the energy balance equation for h.p. pos. columns. The energy balance equation put forward by Suits and based on the Nusselt relation is considered and some refinements in his analysis result in better agreement between theory and experiment. This theory only takes into account energy losses due to convection and conduction, but the neglect of radiation losses is justified for a wide range of conditions by reference to experimental values of radiation efficiencies. The effect of a longitudinal magnetic field on h.p. arcs is then investigated. From the point of view of the energy balance equation the action of a magnetic field is to reduce the contributions of the charged particles to the conduction and convection losses from the column. Horizontal and vertical arcs are considered separately, as the nature of the convection, and hence the effect of a magnetic field is not the same in the two cases. The theory predicts that the action of a magnetic field will tend to a limit with sufficiently strong fields, and certain simple relations are deduced which should apply in this case. According to the theory, when the radius of a h.p. arc is reduced by a magnetic field the arc temperature must rise (incidentally, only by a relatively small amount) and the pos. column gradient may increase or decrease, depending on certain relations which are specified. There are virtually no experimental data available for

these conditions, but the scant data available are in general agreement with the theory. A.

537.525.6 : 538.56

5137. Observations on radio-frequency oscillations in low-pressure electrical discharges. N. R. LABRUM AND E. K. BIGG. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 356–68 (*May*, 1952).

The generation of high-frequency energy by electrical discharges in air at low pressures has been investigated by observations with several types of discharge tube, at frequencies near 200 Mc/s and below 2 Mc/s. Random noise of high intensity was observed in both these frequency ranges, and was found to be associated with a field reversal in the discharge. Coherent oscillations were also observed at the lower frequencies, and there was evidence that these were the cause of the striations of the positive column. A.

537.525.8

5138. Gaseous discharges: characteristics of maintained h.f. discharges. M. CHENOT. *C.R. Acad. Sci.* [*Paris*] **234**, 1152–5 (*March* 10, 1952) *In French.*

Describes the current/voltage characteristics for certain l.p. glow discharges at frequencies of 49 and 55 Mc/s, and shows also how such discharges may operate effectively as sources of e.m.f. J. D. CRAGGS

537.525.8

5139. The operation of a water-cooled hollow cathode discharge in an atmosphere of helium. J. ROIG AND M. BÉCART. *C.R. Acad. Sci.* [*Paris*] **234**, 1262–4 (*March* 17, 1952) *In French.*

Voltage/current characteristics for gas pressures varying from 0·48 to 7 mm Hg are given. The effect of external circuit resistance is also shown graphically Rapid degassing of the cathode at high energy inputs is obtained, with a resulting contamination of the helium. J. D. CRAGGS

537.525.8

5140. The dark current in the intermittent glow discharge in hydrogen. H. RITOW. Letter in *Phys. Rev.*, **86**, 130–1 (*April* 1, 1952).

Describes measurements of the current flowing in the dark intervals between the flashes produced in an intermittent, relaxation oscillation, glow discharge. J. D. CRAGGS

537.525.83

5141. On the measurement of current density at the cathode of a glow discharge and Aston's law at low pressures and high discharge voltages. R. M. CHAUDHRI AND M. A. BAQUI. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 324–8 (*May*, 1952).

A method has been described for determining the current density on a plane cathode of a glow discharge over a wide range of pressure and voltage. It is shown that Aston's relation, $V = E + F\sqrt{i/P}$, holds good down to as low a pressure as 2×10^{-2} mm Hg and up to as high a voltage as 3000 V. The work of the earlier investigators extends up to a voltage of about 1000 V and a pressure not much below 10^{-1} mm Hg. It is also seen from these experiments that the distribution of current over a plane cathode is a function of the discharge pressure and is in general independent of voltage and current. A.

537.528

5142. High values for the electrical breakdown strength of liquids. W. D. EDWARDS. Letter in *J. Chem. Phys.*, **20**, 753–4 (*April*, 1952).

Breakdown strengths of common organic liquids 20 to 100% above literature values were obtained by ensuring the complete absence of minute particles. Rectangular (10 μsec) and sawtooth pulses give the same values. D. H. WHIFFEN

X-RAYS 537.531

537.531 : 535.343

5143. The *L* absorption spectrum of nickel. An anomaly. Y. CAUCHOIS. Letter in *Phil. Mag.*, **43**, 375 (*March*, 1952).

The L_{III} absorption edge is displaced from the emission edge towards lower energies and by several tenths of an eV. But when the absorbing foil is raised above the Curie temperature, the two edges occur at nearly the same energy. A. D. LE CLAIRE

537.531 : 535.343

5144. The M_5 and M_4 X-ray absorption edges of tantalum. D. D. DOUGHTY AND J. W. MCGRATH. Letter in *Phys. Rev.*, **85**, 1040 (*March* 15, 1952).

These were measured using a Siegbahn type vacuum spectrograph. There is a significant deviation from Whitmer's values (1931) and a small discrepancy with respect to calculated values possibly due to the mutual influence of the atoms in a crystal lattice. W. J. SWIATECKI

537.531 : 535.343

5145. X-ray absorption line-width and electron stopping power calculated with a screened Coulomb interaction. G. E. LEE-WHITING. *Proc. Roy. Soc. A*, **212**, 362–76 (*May* 7, 1952).

Assuming that the polarization of a free electron gas about an electron moving through it gives rise to an exponential screening of the Coulomb potential, a method is given by which the screening parameter can be calculated. With such an interaction, a method is found for calculating the frequency of collisions and the rate of loss of energy of an excited electron in an electron gas. From these calculations the X-ray absorption line-width and the stopping power for electrons of the electron gas are deduced. High-energy asymptotic expansions are found for both quantities. When the time-dependent perturbation method is applied to the same problem, the usual simplifying assumptions are seen to be incompatible. A possible case of the same sort of failure in the calculation of Auger-effect transition probabilities in an isolated atom is pointed out. A.

537.531 : 535.343.2

5146. On temperature limits for the vanishing of fine and hyperfine structure in the X-ray absorption spectra of different elements. A. I. KOSTAREV. *Zh. Eksper. Teor. Fiz.*, **21**, 917–22 (*No.* 8, 1951) *In Russian.*

The theory of the temperature dependence developed by the author [Abstr. 7928 (1951)] is applied to Ca, Ni, Zn, Hg, Pt, Pb, giving agreement with experiment. J. JACOBS

537.531.08

5147. A note on the determination of half-value layers of soft X-rays. M. T. Morrison and G. W. Reed. *Brit. J. Radiol.*, **25**, 270–2 (*May*, 1952).

A method is described of deriving a reliable half-value layer of X-radiation from measurements made with a dosemeter whose readings require to be corrected for quality. The magnitude of the corrections to the observed half-value layer is considered and the effect this has on the dosemeter quality factor is discussed. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.392.26 : 621.384.62

5148. Linear electron accelerator to one million volts. A. T. Starr, G. King and L. Lewin. *Elect. Commun.*, **28**, 186–94 (*Sept.*, 1951).

Describes an E_0 guide with irises, in which electrons may be accelerated to about 1·2 MeV. The X-ray output, with 0·6 MW input at 10 cm wavelength, was 0·5 r/min at 1 m target distance at a beam current of 60 mA. A maximum beam current of 400 mA was available. J. D. CRAGGS

537.533.72

5149. The refractive index in electron optics. W. Ehrenberg and C. R. Siday; W. Glaser. Letters in *Proc. Phys. Soc.* [*Lond.*] *B*, **64**, 1088–9 (*Dec.*, 1951).

Correspondence relating to criticisms made by Ehrenberg and Siday of the validity of some generalized expressions for μ derived by Opatowski from extensions of Glaser's 1933 result. A. H. W. BECK

537.533.72

5150. A reduced equation for the trajectories in an electron mirror. M. Bernard. *C.R. Acad. Sci.* [*Paris*] **234**, 606–8 (*Feb.* 4, 1952) *In French.*

The reduced equation given by Picht for the electron lens have already been discussed [Abstr. 1846 (1952)]. This note gives an analogous expression for an electron mirror. The expression gives the trajectories if a single characteristic function of the system is known, which only contains the first derivative of the potential and is everywhere finite.

A. H. W. BECK

537.533.72

5151. The virtual optics of the median plane of axially symmetric magnetic prisms. J. C. E. Jennings. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 256–65 (*April*, 1952).

The angle between the asymptotes of a ray is developed as a power series in its impact parameter about some value which characterizes the "principal ray." When this value is zero, the principal points of the equivalent lens coincide at the axis of symmetry; in all other cases it is "thick." The focal length is here associated with the coefficient of the linear term, the transverse aberrations with those of the higher terms. The quadratic aberration vanishes for a wide range of relative $H\rho$ if the principal ray is suitably chosen. Foci with quadratic aberration are intercepts of the caustic curve, whose cusp lies at the cubic focus. The dependence of aberration upon magnification and the conditions in which the cubic as well as the quadratic aberrations vanish are discussed. A.

537.533.72

5152. Measurements of the electron-optical properties of solenoid prisms. W. Ehrenberg and J. C. E. Jennings. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 265–75 (*April*, 1952).

Cathode rays were deflected and focused in the median plane between a pair of similar coaxial solenoids. Foci free of quadratic aberration were found at all pole separations and ratios of electron momentum to field strength, when the impact parameters of the electrons were suitably selected. This property would enable a spectrum to be photographed with fairly uniform quality over a considerable range of $H\rho$. The loci of these foci were found. Values of the aberration coefficients and of the dispersion are given. A.

537.533.72 : 535.41

5153. Electron interferometer. L. Marton. Letter in *Phys. Rev.*, **85**, 1057 (*March* 15, 1952).

Discusses the principles of an electron beam interferometer of the Michelson or Jamin type. Thin lamellar crystals are suggested for beam splitting. Calculations on the necessary tolerances indicate that these are well within the bounds of experimental possibility, and construction is under way. Possible uses are indicated. A. H. W. BECK

537.533.72 : 621.317.6 : 621.385.833

5154. A direct method for measuring the high voltage stability of the electron microscope. T. Mulvey. *J. Sci. Instrum.*, **29**, 149–50 (*May*, 1952).

A method is described for measuring very small changes in the focal length of a magnetic electron lens and hence the stability of the accelerating voltage in the electron microscope. A.

537.533.72

5155. A β-spectro-goniometer for coincidence and angular correlation measurements. Design and applications. K. Siegbahn. *Ark. Fys.*, **4**, 223–71 (*Paper* 10, 1952).

The instrument consists of 2 focal isolation β-spectrometers which can be rotated between 90° and 180° relative to one another about the same source; the Geiger counters in the 2 spectrometers are put in coincidence. Certain coincidence rate formulae are generalized for angular correlation work, and details are given of investigations of β-ray and conversion electron coincidence, β–γ coincidence and β-ray and electron angular correlation, with the isotopes Ga^{67}, ThB, Tm^{170}, Au^{199}, Sm^{153} and Na^{24}. Revised disintegration schemes are suggested for Ga^{67}, Au^{199} and Sm^{153}. J. C. E. JENNINGS

537.533.75

5156. The straggling of electrons below the critical energy. K. C. Hines. *Aust. J. Sci. Res.*, *A*, **4**, 450–8 (*Dec.*, 1951).

The straggling in range of electrons which lose energy by collision and radiation processes is investigated. A diffusion equation is set up and a solution obtained following the method of Bhabha and Chakrabarty. In a given material the results apply

or initial energies up to about half the critical energy. A discussion of the application of the results to the interpretation of experiments on meson decay electrons is given. A.

537.533.8

5157. On a new method of determining the depth of emergence of secondary electrons. A. Ya. Vyatskin. Note in *Zh. Eksper. Teor. Fiz.*, **21**, 851–2 (*No.* 7, 1951) *In Russian.*

An analysis of the secondary electron emission from thin metal foils [Abstr. 8796 (1950)] has shown the existence of a "fine structure" in the energy spectrum. This is explained in terms of the interaction of the primary electrons with the metallic electrons moving in the periodic field of the lattice. A simple expression for the position of the maxima in the spectrum in terms of the lattice dimensions is tested for Mo [Haworth (1935)]. W. J. SWIATECKI

537.533.9

5158. Radiation from an electron in a magnetic field. D. L. Judd, J. V. Lepore, M. Ruderman and P. Wolff. Letter in *Phys. Rev.*, **86**, 123 (*April* 1, 1952).

Agreement is found between the results of a classical treatment [Abstr. 5460 (1949)], and of Parzen's quantum-mechanical calculation [Abstr. 330, 1952)], of the radiation from an electron in a magnetic field, after an invalid approximation made by Parzen is corrected. R. H. DALITZ

537.533.9

5159. Radiation loss of electrons in the synchrotron. H. Olsen and H. Wergeland. Letter in *Phys. Rev.*, **86**, 123 (*April* 1, 1952).

Parzen's quantum-mechanical calculation [Abstr. 330 (1952)] of the radiation from an electron in uniform circular motion is corrected, and the extra terms calculated lead to final agreement with the classical result [Abstr. 5460 (1949)]. R. H. DALITZ

537.534 : 621.384.6

5160. A 200 kV high tension set for the acceleration of H^3 and He^3. K. W. Allen, E. Almqvist, J. T. Dewan and T. P. Pepper. *Canad. J. Phys.*, **29**, 557–68 (*Nov.*, 1951).

A 2-stage voltage doubler followed by electronic stabilizer giving constant h.t. to $\pm 0{\cdot}05\%$ is coupled to an r.f. ion source of special design yielding 200 μA beam current. Gas consumption is only 9 cm^3/hr and differential pumping recovers more than 95% of the gas passing into the accelerating tube. F. T. FARMER (R)

537.534.72

5161. Direction double focussing of particles varying in velocity and mass in rotationally symmetric electric-magnetic fields. H. W. Franke. *Öst. Ingen-Arch.*, **5**, 371–87 (*No.* 4, 1951) *In German.*

The Glaser theory of the motion of charged particles in ordinary electric-magnetic fields [Abstr. 2739 (1951)] is extended to the case of particles divergent in velocity and mass. The magnitudes, characteristic for dispositions of velocity and mass spectrography, are calculated according to the case of double direction focusing. A.

537.534.72

5162. Determination of ion paths in crossed electric and magnetic fields. M. E. Reinders, C. J. Zilverschoon and J. Kistemaker. *Appl. Sci. Res. B*, **2**, 264–8 (*No.* 4, 1952).

Ion paths in crossed electric and magnetic fields were calculated, using a step-by-step method. Two examples are given: the ions in a Nier source; and the ions passing the acceleration electrode of an electromagnetic isotope separator. The magnetic field was homogeneous; the electric field was determined by means of a resistor network. A.

537.534.74

5163. The scattering of 9·6-MeV protons by carbon, aluminium, and magnesium. C. J. Baker, J. N. Dodd and D. H. Simmons. Letter in *Phys. Rev.*, **85**, 1051–2 (*March* 15, 1952).

4 mg/cm^2 foils were used in a remotely controlled scattering chamber. A proportional counter telescope and Al absorbers were used to measure ranges. An absolute measure of charge in the direct beam was obtained with a Faraday cup. Angular distributions are given. F. R. HOLT

537.534.74

5164. The elastic scattering of deuterons by deuterons. R. J. Runge. Letter in *Phys. Rev.*, **85**, 1052 (*March* 15, 1952).

The singlet, triplet and quartet scattering amplitudes in elastic *d–d* scattering are calculated in Born approximation, the nucleon-nucleon potentials (apart from the Coulomb terms) being of Gaussian form with arbitrary exchange character, the deuterons being represented by *S* wave-functions of Gaussian form. The corresponding angular distribution and the validity of the calculation are discussed. R. H. DALITZ

537.534.9

5165. The relative ionization produced by low energy protons, deuterons and alpha-particles in various gases. P. R. Tunnicliffe and A. G. Ward. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 233–40 (*April*, 1952).

Mono-energetic neutrons have been used to produce recoil protons, deuterons and α-particles in a proportional counter. The maximum pulse sizes produced by the different recoil particles are compared with the accurately known ratios of maximum recoil energies. From the results for protons and deuterons it can be inferred that, for protons between 200 and 550 keV energy, the ionization is proportional to the energy with a deviation of less than 1%. The total ionization in argon produced by a proton is about 8% greater than that of an α-particle of equal energy, for energies between 200 and 400 keV. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

5166. Elimination of coincidences caused by back-scattering of electrons in an arrangement of counters without walls. Results for P^{32} and S^{35}. M. Duquesne. *C.R. Acad. Sci.*[*Paris*] **234**, 1159–61 (*March* 10, 1952) *In French.*

The source, in a hole in the centre of a large Cu disk, was placed between two separated window-less

G.M. counters in an argon-filled chamber. Absorbers could be interposed between the source and one counter. From the variation of recorded coincidences with thickness of absorber, true coincidences were found for P^{32}, but were doubtful for S^{35}. F. R. HOLT

537.542

5167. A thick-walled ionization chamber for measuring the intensity of X-radiation of energy up to 25 MeV. B. H. FLOWERS, J. D. LAWSON AND E. B. FOSSEY. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 286–95 (*April*, 1952).

A thick-walled ionization chamber suitable for measuring the radiation intensity from synchrotrons and betatrons operating at energies up to 25 MeV is described. Calibration curves giving the current in the chamber per incident photon as a function of photon energy are given. The effect of wall thickness and secondary X-rays produced in the wall have been considered and included in the calculations. Experimental results consistent with the theory are described. A.

537.542

5168. The natural scintillations from uranyl nitrate crystals. S. G. COHEN AND Y. FEIGE. Letter in *Phys. Rev.*, **85**, 1049 (*March* 15, 1952).

The scintillations due to natural radioactivity in a $3\times4\times8$ mm crystal of uranyl nitrate have 3 to $4\times$ the frequency of background noise pulses from the photomultiplier. G. F. J. GARLICK

537.542

5169. A simple combined electrometer charger for radiation protection pocket ionisation chambers. A. H. WAPSTRA. *Appl. Sci. Res. B*, **2**, 269–72 (*No.* 4, 1952).

A robust valve electrometer for the measurement of the voltage loss of pocket ionization chambers is described; all supply voltages, filaments included, are stabilized with neon filled valves. The same instrument can be used as a charger. A.

537.542

5170. Automatic control of Geiger–Müller counters. G. KLEIN AND N. C. DE TROYE. *Appl. Sci. Res. B*, **2**, 291–3 (*No.* 4, 1952).

A device is described which automatically measures and records the variation of counting efficiency with voltage of 12 counters in 1½ hours.

537.542 : 621.318.572

5171. Ten-channel pulse analyser. M. LANGEVIN AND G. ALLART. *C.R. Acad. Sci.* [*Paris*] **234**, 515–18 (*Jan.* 28, 1952) *In French.*

An arrangement for studying the distribution-in-height of pulses from a scintillation or proportional counter. The essential component in the circuit is a 10-anode tube with a ribbon-shaped electron beam. The ten channels are defined by the thresholds of sensitivity of these anodes. The maximum rate of counting using scaling counters is 20 000 for a 1% loss. A curve is shown of gamma-ray measurements on Au^{198}. S. C. DUNN (R)

537.542 : 621.318.572

5172. A single-channel pulse-height discriminator of high speed and stability. G. T. WRIGHT. *J. Sci. Instrum.*, **29**, 157–60 (*May*, 1952).

Discrimination between voltage pulses of different magnitudes is effected by simultaneously applying each pulse and its differential to the X and Y deflecting plates respectively of an oscilloscope and by scanning the screen in the X direction with a thin optical slit and a photomultiplier. The pulse height distribution is displayed on a second oscilloscope and recorded photographically. The apparatus is free from zero drift and drift of channel width. The maximum counting rate for regularly occurring pulses is 3×10^5 per sec. A.

537.542 : 621.395.645.3

5173. Improved overload response of the A–1 amplifier. F. I. MAGEE, P. R. BELL AND W. H. JORDAN. *Rev. Sci. Instrum.*, **23**, 30–3 (*Jan.*, 1952).

It is frequently desirable to use a linear amplifier to study signals having a wide range of amplitudes. Modifications have been made to the A–1 amplifier [*Rev. Sci. Instrum.*, **18**, 703–5 (*Oct.*, 1947). Abstr. 701 B (1948)] which permit it to be used with signals up to 300 times the normal overload value. A.

537.542

5174. Effect of traces of ammonia on track formation in a continuous cloud chamber. R. E. VOLLRATH. Letter in *J. Chem. Phys.*, **20**, 536–7 (*March*, 1952).

537.542

5175. Photochemical method of maintaining a continuous cloud chamber. R. E. VOLLRATH. Letter in *J. Chem. Phys.*, **20**, 537 (*March*, 1952).

The generation of HCl in the uniform concentration required is effected photochemically throughout the chamber volume: the photochemical oxidation of chloroform is suitable. F. LLEWELLYN JONES

537.543 : 621.385.1.029.6

5176. Effect of thermal-velocity spread on the noise figure in traveling-wave tubes. P. PARZEN. *J. Appl. Phys.*, **23**, 394–406 (*April*, 1952).

Effects of thermal-velocity spread on the noise figure of a travelling-wave tube have been computed by extending a method of Hahn. To accomplish this, it has been necessary to work out a new theory for the diode-drift tube and travelling-wave tube that includes the effect of the thermal-velocity spread at very high frequencies. Some computations are given for conditions met in practice. A.

537.543.5

5177. Low-frequency noise spectra of hot-filament low-pressure discharge tubes. H. MARTIN AND H. A. WOODS. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 281–6 (*April*, 1952).

Measurements have been made of the l.f. noise spectrum of a number of hot-cathode discharges in Hg vapour saturated at room temperature. As previously reported by Cobine and Gallagher, the spectrum is continuous, with superposed peaks. The latter can be partly attributed to harmonic components of ionic relaxation oscillations. The upper frequency limit of the continuum exceeds 10 Mc/s in some instances. Most of the noise from the tubes studied originated near the cathode. Some relations have been traced between the noise and oscillations and position on the current-voltage characteristic curve for the tube, but there is variation from one tube to another. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 539.153 : 523.76

.78. Collision processes involving highly ionized oms. E. R. HILL. *Aust. J. Sci. Res. A*, **4**, 437–49 *Dec.*, 1951).

The cross-section of Fe XIV for inelastic collisions sulting in the transition from the $^2P_{3/2}$ to the $^2P_{1/2}$ ate of the ion, for electron collision ionization, and or radiative recombination of Fe XIV and Mg X are lculated by wave mechanical methods. A method given whereby radiative recombination cross-sections f all highly ionized atoms may be calculated. Where ossible, the cross-sections obtained are compared ith corresponding results given by the classical uantum theory. Finally, the wave mechanical values re used to verify the general conclusion, obtained sing classical quantum values of the cross-sections, hat the agitation temperature of the coronal electrons s about $10^{6°}$K. A.

537.564 : 539.18

5179. Experimental study of the ionization produced n gases by mesons of great energy. J. BECKER, . CHANSON, E. NAGEOTTE, T. PRICE, P. ROTHWELL ND P. TREILLE. *C.R. Acad. Sci.* [*Paris*] **234**, 1155–7 *March* 10, 1952) *In French.*

A system of proportional counters and a cloud chamber at 3650 m above sea level were used to measure simultaneously specific ionization and momentum of 800 tracks in the range 0·17–5 BeV. A plot of ionization against momentum shows a minimum followed by a logarithmic increase, in agreement with calculations for a μ-meson.

W. J. SWIATECKI

537.583 : 621.385.032.216

5180. The influence of the core material on the thermionic emission of oxide cathodes. H. A. POEHLER. *Proc. Inst. Radio Engrs*, **40**, 190–6 (*Feb.*, 1952).

Alloys of Ni with 4·8% Mn, 4·0% Al, 0·38% Mg, and 3·5% W were used as cores, with pure electrolytic Ni as a core being used as a control. The experiments showed that both the d.c. and pulsed emission of oxide cathodes are dependent on the core to a marked degree. A.

COSMIC RAYS 537.591

537.591

5181. Absorption experiment to detect the cosmic ray albedo at high altitudes. J. R. WINCKLER. Letter in *Phys. Rev.*, **85**, 1053–4 (*March* 15, 1952).

A 6·5-in thick Pb block below a counter telescope was used to try to subtract the upward moving flux, at 27 g/cm, atmospheric depth, and zenith angle of 60°. It was found that the absorber itself generated an albedo effect proportional to the number of particles incident on its top and sides. J. HUGHES

537.591

5182. Application of Čerenkov radiation to the cosmic ray albedo problem. J. R. WINCKLER. Letter in *Phys. Rev.*, **85**, 1054–5 (*March* 15, 1952).

The Cherenkov radiation produced in a lucite block, by charged, relativistic, downward moving particles, was detected by a photomultiplier. Measurements, of the efficiency of the counter, at various zeniths, and atmospheric depths, and of the relativistic albedo at 60° zenith, and an atmospheric depth of 17 g/cm^2, are given as a function of the bias energy. J. HUGHES

537.591.1 : 539.18

Decay of V^0-particles. *See Abstr.* 5331

537.591.15

5183. The structure of extensive showers. I. D. CAMPBELL AND J. R. PRESCOTT. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 258–68 (*April*, 1952).

The form of the structure function of extensive showers at small distances from the core has been investigated by observations of coincidences between ionization chambers at sea level. The observations considered are the decoherence curve and the burst-ratio distribution. Both sets of results indicate a structure function that varies as $1/r^{0·8}$ for small r (less than 0·04 lateral shower units at sea level) as opposed to the well-known Moliere function which behaves as $1/r$ for small r. A modified structure function is given in tabular form. The advantages of the burst-ratio distribution method of studying the structure function are discussed. A.

537.591.3

5184. Absorption of the nucleonic component of cosmic rays in the atmosphere between sea level and 4 000 m altitude. M. TEUCHER. *Z. Naturforsch.*, **7a**, 61–3 (*Jan.*, 1952) *In German.*

G5 emulsions exposed at five altitudes ranging from sea level to 4 000 m showed an exponential attenuation of star (3 or more black tracks longer than 60 μ) formation with range (127 $\pm$ 3) g/cm^{-2}. J. G. WILSON

537.591.8 : 539.172

5185. Analysis of two σ-stars. B. COUGNET, J. ROEDERER AND P. WALOSCHEK. Note in *Z. Naturforsch.*, **7a**, 201–2 (*Feb.*, 1952). *In German.*

Two cosmic-ray stars whose prongs were confined to the emulsion were completely identified as $_6C^{12} + \pi^- \rightarrow {}_3Li^8 + {}_2He^3 + n^\circ$ and $_6C^{12} + \pi^- \rightarrow {}_2He^4 + {}_2He^4 + {}_1H^3 + n^\circ$. W. J. SWIATECKI

537.591.8 : 539.172

5186. The double star effect in nuclear emulsion plates exposed to the cosmic rays. G. DAVIS. Letter in *Phil. Mag.*, **43**, 472–3 (*April*, 1952).

It is shown that the excess of close star pairs reported by Li [Abstr. 1170 (1951)] is probably due to accidental bias in searching. H. ELLIOT

537.591.8 : 539.172

5187. Application of the Fermi model to cosmic-ray events of primary energy greater than 10^{13} eV. W. E. HAZEN, R. E. HEINEMAN AND E. S. LENNOX. *Phys. Rev.*, **86**, 198–204 (*April* 15, 1952).

The Fermi model for nucleon-nucleon collisions at high energies was used to calculate the energy distribution, the energy dependence of the angular distribution and the number of emitted pions as a function of primary energy and impact parameter. The effect on the pion distribution of nucleon-antinucleon production in the same collision is calculated. The results approach agreement with air-shower observations. A.

MAGNETISM 538

538.113

5188. The free-electron model and the diamagnetism of aromatic hydrocarbons. M. W. NATHANS. Letter in *J. Chem. Phys.*, **20,** 741–2 (*April*, 1952).

An extension of work by Pauling (1936) who considers the mobile electrons to move freely over the hexagonal network of condensed benzene rings. Calculations are made using a free electron model and making assumptions regarding the magnitude of the mean square radius of the electron orbit, with corrections to allow for "short cuts." Agreement with experiment is good for small molecules but poor for large molecules. E. P. WOHLFARTH

538.114

5189. A spin-wave treatment of the saturation magnetization of ferrites. H. KAPLAN. Letter in *Phys. Rev.*, **86,** 121 (*April* 1, 1952).

Spin-wave theory is applied to ferrites containing two types of atoms with nearest neighbour interaction. The relative magnetization at low temperatures is expressed as $1-(T/T_0)^{3/2}$, where T_0 is a function of the exchange integrals and the saturation moments of the atoms. The antiferromagnetic case is also studied. E. P. WOHLFARTH

538.22 : 538.566 : 537.226.2

An optical method for the determination of the complex dielectric constant ϵ and the magnetic permeability μ. *See Abstr.* 5104

538.221

5190. Magnetic resonance in a system containing two magnetic sublattices. R. K. WANGSNESS. *Phys. Rev.*, **86,** 146–8 (*April* 15, 1952).

The normal frequencies are calculated classically including exchange, demagnetizing and anisotropy fields. Ferromagnetic and antiferromagnetic resonance conditions are shown to be special cases of a general formula which is obtained. Conditions under which the Kittel ferromagnetic frequency should be applicable to the two-lattice system are discussed, as well as the possibility of resonance in the exchange field. A.

538.221 : 538.541

5191. Thermal investigation of thin mumetal tapes in weak alternating fields. C. ABGRALL AND I. EPELBOIN. *C.R. Acad. Sci.* [*Paris*] **234,** 1265–7 (*March* 17, 1952) *In French.*

Experimental study of the temperature dependence of the anomalous resistance ratio ρ/ρ_a (ρ, directly measured resistance, ρ_a, value deduced from loss measurements). This ratio is > 1 and increasingly so for very thin tapes, but is sensibly temperature-independent between room temp. and $-180°$C. A tentative interpretation of the results is given. E. P. WOHLFARTH

538.221 : 550.38

5192. Reverse thermo-remanent magnetism. T. NAGATA. Letter in *Nature* [*Lond.*] **169,** 704–5 (*April* 26, 1952).

Describes experiments on hypersthene hornblende dacitic pumices containing magnetite grains. The thermoremanent magnetization induced by cooling in a low magnetic field was found to be opposite in direction to the field direction as in some igneous rocks in the earth's field. The magnetic and thermal conditions for the effect to be observed were investigated; the reasons for its occurrence are not yet clear. E. P. WOHLFARTH

538.222/.224

5193. Chemical effects in nuclear magnetic resonance and in diamagnetic susceptibility. N. F. RAMSEY. *Phys. Rev.*, **86,** 243–6 (*April* 15, 1952).

An expression for the magnetic shielding of nuclei in solids and in molecules is developed, and an approximation is obtained that is particularly suited to substances containing heavy atoms. The temperature dependence of the magnetic shielding which arises when there are several low lying states of the molecules is discussed. It is shown that only slight changes in the various formulae make them applicable to the diamagnetic susceptibility. A.

538.222

5194. Paramagnetic resonance absorption in Ce^{+++} and Nd^{+++} sulphates. V. YA. KURENEV AND S. G. SALIKHOV. *Zh. Eksper. Teor. Fiz.*, **21,** 864–8 (*No.* 8, 1951) *In Russian.*

At room temperature both at $2{\cdot}38$ and $6{\cdot}75\times10^8$ c/s $Ce_2(SO_4)_3$, $Nd_2(SO_4)_3$ and $Nd_2(SO_4)_3.8H_2O$ show a single peak, but at 90°K and $2{\cdot}38\times10^8$ c/s these compounds as well as $Ce_2(SO_4)_3.8H_2O$ show a double peak in χ'' over the range 0–1 300 oersteds. D. H. WHIFFEN

538.222

5195. Anomalous paramagnetism and exchange interaction in copper acetate. B. BLEANEY AND K. D. BOWERS. Letter in *Phil. Mag.*, **43,** 372–4 (*March*, 1952).

Gives a theoretical interpretation of the room temperature maximum found in the paramagnetic susceptibility of this salt by Guha [Abstr. 5578 (1951)] and of the anomalous resonance spectrum observed by the authors. Strong isotropic exchange forces are postulated between isolated pairs of Cu ions; the mechanism is similar to that usually postulated in antiferromagnetics. E. P. WOHLFARTH

538.222

5196. Thermomagnetic investigation of amidosulphonates of nickel, cobalt and iron: divalent ions. N. PERAKIS AND T. KARANTASSIS. *C.R. Acad. Sci.* [*Paris*] **234,** 1267–8 (*March* 17, 1952) *In French.*

Investigations between room temp. and $-190°$C on $(NH_2SO_3)_2M$(M = Ni, Fe) indicate that the observed Bohr magneton number differs only slightly from that calculated on the assumption that spin only is effective, while for M = Co the difference is larger, indicating incomplete quenching of the orbital moment. E. P. WOHLFARTH

538.222

5197. Thermomagnetic investigation of metallic praseodymium. C. HENRY LA BLANCHETAIS. *C.R. Acad. Sci.* [*Paris*] **234,** 1353–4 (*March* 24, 1952) *In French.*

Measurements were carried out on 99·3% Pr between 80° and 1100°K. The inverse susceptibility, temperature curve is linear up to 500°K ($p_B = 3{\cdot}56$, cf. $3{\cdot}62$

Pr^{+++}) and then bends towards the temperature s. The susceptibility was field-independent over e temperature range investigated. E. P. WOHLFARTH

538.24

98. Discontinuities in the variation of magnetiza- n with temperature. V. L. NEWHOUSE. *Proc. Phys. c. [Lond.] A*, **65**, 325–8 (*May*, 1952).

It is demonstrated that magnetic discontinuities company changes of temperature at constant field. he effect is investigated for hard-drawn Fe and Ni d is accounted for in terms of two mechanisms, he associated with the decrease of coercivity with e of temperature and the other associated with the rsperse field due to the thermal oscillations of the rriers of magnetic moment. A.

538.245

.99. Domain patterns on FeSi crystals. C. F. YING, LEVY AND R. TRUELL. Letter in *Phys. Rev.*, **86**, 3–34 (*April* 1, 1952).

Magnetic powder patterns on a 3·8% Si FeSi rystal reveal a "subdomain" structure within the rge domains. Another pattern shows the bending a thin domain around an inclusion. A. E. DE BARR

LECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

200. Lessons on the principles of classical electro- ynamics. A. MERCIER. *Neuchatel, Editions du Griffon* 1952) 74 *pp. In French.*

A rigorous development is based on a system of irreducible dimensions, 3 mechanical and one lectric, and the importance is stressed of the con- tants ε^0 and μ_0 characterizing the vacuum. The undamental field vectors are taken to be (**E**, **B**), the air (**D**, **H**) being regarded as auxiliary fields. Polari- ation is discussed in detail and it is shown that, in eneral, the Poynting vector must be expressed in terms f $\mathbf{E}\times\mathbf{B}$ and not $\mathbf{E}\times\mathbf{H}$. A careful distinction is main- ained throughout the book between polar and axial ector fields. Postulates for special relativity are onsidered and the Lorentz transformations are lerived. A final chapter summarizes an axiomatic levelopment of electromagnetic theory in terms of he algebra of Clifford numbers. R. A. NEWING

538.3 : 538.52 : 621.3.011

5201. Electromagnetic induction and magnetoelectric nduction. G. VALLAURI. *Alta Frequenza*, **20**, 227–46 *Dec.*, 1951) *In Italian.*

The symmetrical nature of the analogy between corresponding magnitudes in the magnetic and electric ystems is discussed with the aid of tables. Experi- ments are described which furnish a direct proof of he validity of Maxwell's hypothesis on the magneto- notive force generated by an electric displacement urrent. Details are given of the apparatus used vhich includes a 1000 c/s Duddell alternator, special tep-up transformer of high resonant frequency, test ixture and tuned amplifier. The test fixture consisted f a screened box fitted with h.v. electrodes and a creened, wound, magnetic core. Readings were taken of the current in the winding as a function of the electrode voltage for a variety of arrangements inside the test fixture. These were compared with calcula- tions made by a graphical method and agreed satis- factorily. S. C. DUNN (R)

538.551 : 537.533 : 530.162 : 621.392.52

5202. On the theory of filtration of signals. L. A. ZADEH. *Z. angew. Math. Phys.*, **3**, 149–55 (*No.* 2, 1952).

An outline is given of a theory of linear variable filters. With the use of such filters it would be possible theoretically to separate a signal completely from associated noise even in overlapping bands in the frequency spectrum. W. T. BLACKBAND

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

5203. Magneto-hydrodynamic waves in gases. V. L. GINZBURG. *Zh. Eksper. Teor. Fiz.*, **21**, 788–94 (*No.* 7, 1951) *In Russian.*

The equations of motion of an ionized liquid in a magnetic field which is strong in comparison with the field produced by the motion of the ions, are derived from first principles as equations of motion of a continuous medium. In the case of a gas this method is inadequate, and the analysis must be based on the equations of motion of individual particles in which, apart from the forces which can be taken into account electrodynamically as an action of electro-magnetic field, forces arising from impacts with other particles are introduced on the basis of kinetic theory of gases. Two cases are considered separately: one in which the gas is fully ionized, forming a "plasma," and the other where neutral particles are also present. The first case is mainly applicable to the ionized gases near the surface of the sun, while the second case is mainly applicable to the ionized layers surrounding the earth. The solutions of these equations are interpreted as waves in the medium. N. S. JAPOLSKY

538.56 : 537.525.6

Observations on radio-frequency oscillations in low-pressure electrical discharges. *See Abstr.* 5137

538.561

5204. On the non-radiating free oscillations of a conducting ball surrounded by a layer of air and an ionosphere. W. O. SCHUMANN. *Z. Naturforsch.*, **7a**, 149–54 (*Feb.*, 1952) *In German.*

The non-radiating natural oscillations of a perfectly conducting ball are determined for the B_ψ, E_ϱ and E_θ waves (*H*-waves), when the homogeneous plasma atmosphere borders without impact damping on the thin layer of air enclosing the ball. Z. F. WOJNAR

538.566 : 621.396.11

5205. Diffraction of electromagnetic waves by openings in plane conducting sheets. J. P. VASSEUR. *Onde Elect.*, **32**, 3–10 (*Jan.*, 1952) *In French.*

There is no general formula for diffraction based on Huyghens' Principle. A survey is given of the study of diffraction since Huyghens' time. The

special cases where Maxwell's equations can be integrated directly either by use of curvilinear co-ordinates or Sommerfeld's non-uniform functions are listed. W. T. BLACKBAND (R)

538.566 : 621.396.11

5206. Diffraction of electromagnetic waves by openings in plane conducting sheets. J.-P. VASSEUR. *Onde Elect.*, **32**, 55–71 (*Feb.*, 1952) *In French.*

See also preceding abstract. Kirchhoff's formula expressing Huyghen's principle only applies to diffraction through an aperture in a closed surface. Kottler's theory does not have this defect, but it is in error through neglect of the normal component of the incident wave, and leads to a discontinuity between incident and diffracted fields at the aperture. The theory proposed is an extension of Copson's and it avoids the above defects. W. T. BLACKBAND (R)

538.566

5207. On the diffraction of an electromagnetic pulse by a wedge. J. W. MILES. *Proc. Roy. Soc. A*, **212**, 547–51 (*May* 22, 1952).

The diffraction by a conducting wedge of a transient electromagnetic disturbance in the form of a plane wave discontinuity having arbitrary polarization and direction of propagation is reduced to a pair of two-dimensional scalar problems. The solution to one of these is identical with that previously obtained for the analogous acoustical problem, while the second is attacked in a similar manner, using a Tschplygin transformation to reduce the boundary value problem to one in potential theory, which is then solved by classical means. A.

538.566 : 621.3.013 : 621.396.671

5208. Radiation field of a square, helical beam antenna. H. L. KNUDSEN. *J. Appl. Phys.*, **23**, 483–91 (*April*, 1952).

Rigorous formulae have been derived for the field from a square, helical aerial with a uniformly progressing current wave of constant amplitude. These formulae that have the advantage of great simplicity are of direct use for helical aerials in the meter band, where for practical reasons only square helices are used. Further, in connection with corresponding rigorous formulae for the field from a circular, helical aerial with a uniformly progressing current wave of constant amplitude the present formulae may be used for an investigation of the magnitude of the error introduced in Kraus' approximate calculation of the field from a circular, helical aerial by replacing this aerial with an "equivalent" square helix. This investigation is carried out by means of a numerical example. The investigation shows that Kraus' approximate method of calculation yields results in fair agreement with the results obtained from the rigorous formulas. A statement to the contrary made recently in the literature is shown to rest on a trivial error. A.

538.566.2 : 621.396.11

5209. Reflection of short waves from levels below 100 km. W. DIEMINGER AND A. E. HOFMANN-HEYDEN. Note in *Naturwissenshaften*, **39**, 84–5 (*No.* 4, 1952) *In German.*

Echo signals from an equivalent height of 80 km have been observed at normal incidence on frequencies up to 3 Mc/s. The principal characteristics of the signals are (*a*) the echoes are quite distinct from *E*-layer echoes, (*b*) the equivalent height of reflection is independent of frequency but exhibits a diurnal variation with a minimum at noon, (*c*) the echoes are strongest in the winter daylight period, (*d*) are usually observed on days of high ionospheric absorption. W. J. G. BEYNON

538.566.3 : 621.396.11

5210. A new kind of radio propagation at very high frequencies observable over long distances. D. K. BAILEY, R. BATEMAN, L. V. BERKNER, H. G. BOOKER, G. F. MONTGOMERY, E. M. PURCELL, W. W. SALISBURY AND J. B. WIESNER. *Phys. Rev.*, **86**, 141–5 (*April* 15, 1952).

The discovery and some results of a preliminary investigation of a new type of weak v.h.f. propagation by means of the ionosphere is reported. This form of propagation appears to be observable over ranges out to about 2000 km from the transmitter but is likely to be masked by other kinds of propagation at distances much less than about 1000 km. The initial experiments on a frequency of 49·8 Mc/s reveal the uninterrupted presence of observable signal over a test path of 1245 km, irrespective of season, time of day, or geomagnetic disturbance, though showing dependence in intensity on these factors, and possibly on the meteor activity as well. Some preliminary speculations suggest that the mechanism of this type of propagation may be scattering caused by ever-present irregularities in the *E*-region, and an approximate transmission equation is derived in terms of parameters describing inhomogeneities in the *E* region. Measured signal intensities during periods of h.f. radio fadeouts associated with solar flares never show any reduction in signal. On the contrary, there is usually an enhancement of signal intensity accompanied by a simultaneous weakening of the background noise. This result suggests strongly that the signals are returned from a part of the *E* region near or just below the absorption region for ordinary h.f. radio waves. A.

MAGNETIC EFFECTS 538.6

538.614 : 536.48

5211. Thermal variation of the Faraday effect of pure liquid nitrogen. F. GAUME. *C.R. Acad. Sci.* [*Paris*] **234**, 1445–6 (*March* 31, 1952) *In French.*

Values of the Verdet constant, specific magnetic rotatory power, and rotativity of pure liquid N_2 in the temperature range 63·3°–82·3°K are tabulated. A decrease of the Verdet constant with temperature rise is observed. See also Abstr. 8075 (1951).

G. I. W. LLEWELYN

538.614 : 536.48

5212. Thermal variation of the magnetic rotatory power of mixtures of liquid nitrogen and oxygen. F. GAUME. *C.R. Acad. Sci.* [*Paris*] **234**, 1547–8 (*April* 7, 1952) *In French.*

Results obtained for the Verdet constant of these mixtures indicate considerable deviation from the

litivity law, greater rotations being observed than uld be expected from additivity. At constant nperature, when the density of oxygen in the mixture minishes, an increase in the specific magnetic atory power of the oxygen is found, analogous to e variation recorded in the magnetic susceptibility d magnetic birefringence of oxygen under similar nditions. See also preceding abstract.

G. I. W. LLEWELYN

538.614 : 539.153

13. Paramagnetic rotatory power of nickel iosilicate and the splitting of the ground state of $^{++}$. J. BECQUEREL. *Physica*, **18**, 183–93 (*March*, 52) *In French.*

Earlier experimental results on $NiSiF_6 . 6H_2O$ by e author (1939) are re-examined in the light of cent theoretical work by Ollom and Van Vleck bstr. 7190 (1951)] on the effect of exchange on the erdet constant. E. P. WOHLFARTH

OLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

214. Contribution to the study of the kinetic theory f solids. A. HERPIN. *Ann. Phys.* [*Paris*] **7**, 91–140 *Jan.–Feb.*, 1952) *In French.*

Theoretical investigation of the fundamental rocesses of thermal conduction in solids which is onsidered to be a second-order effect arising from the nharmonic terms. The Debye–Brillouin model of a olid is assumed. The oscillations caused by pro- ressive elastic waves are determined and the coupling etween the waves calculated. The anharmonic otential is calculated so as to obtain a more accurate alue of the coupling coefficient, and Cauchy's elations are generalized. Energy transfers caused by oupling between the waves are considered in detail nd are interpreted as collisions between phonons. his leads to an important difference between longi- udinal and transverse vibrations. The origin of hermal vibrations, looked upon as a phonon gas, is hus considered and the relaxation time and mean ree path (interpreted as the mean distance at which hermal waves can be coupled) are calculated. The elaxation time at high temperatures is proportional o $1/T$. For longitudinal waves of long wavelength t varies as the fourth power of the wavelength and or the transverse waves as the square of the wave- ength. Having the mean free path the result that for perfect solid the thermal conductivity is infinite is btained. Lattice defects and mosaic structures cause he finite values obtained for actual solids.

C. A. HOGARTH

539.11

215. Theory of co-operative phenomena. G. OURNET. Letter in *Phys. Rev.*, **85**, 692 (*Feb.* 15, 1952). A comparison is made between Yvon's theory [Abstr. 1702 (1948)] of order-disorder transformations in binary alloys and that of Kikuchi [Abstr. 5134 (1951)], over which it has certain advantages, using as an example the calculation of the configurational energy above the critical temperature of a 50 at. % simple cubic alloy. A. D. LE CLAIRE

539.11

5216. A theoretical estimate of the effect of radiation on the elastic constants of simple metals. G. J. DIENES. *Phys. Rev.*, **86**, 228–34 (*April* 15, 1952).

Interstitial atoms and vacancies play an important role in the theory of solids and of radiation damage. It is difficult to separate and measure unambiguously these lattice disturbances in metals. It is suggested that measurements of changes in elastic constants may be appropriate in such investigations. An approximate theoretical treatment is given of the change in elastic constants of simple metals caused by the presence of a given small fraction of interstitial atoms and vacancies. The elastic coefficients are calculated from atomic interaction potentials (a simple exponential function for Cu and a Morse function for Na) with relaxation effects taken into account. The presence of a small fraction of interstitials and vacancies results in large increases in the elastic coefficients of Cu. Lattice vacancies alone were found to decrease the elastic coefficients, the change being essentially a bulk effect. Consequently, increases in the elastic moduli measure primarily the fraction of interstitial atoms. In Na, large relaxation occurs around an interstitial and this atomic re-adjustment reduces the effect of the interstitial to the magnitude of a bulk effect. It is concluded that the theoretically predicted effects should be easily observable in Cu or similar metals, provided thermal annealing is prevented. Changes in elastic constants, therefore, may serve as a useful tool for distinguishing between interstitial atoms and lattice vacancies. A.

539.11 : 536.42 : 537.226

5217. Hindered intermolecular rotation in the solid state: thermal and dielectric phenomena in long-chain compounds. J. D. HOFFMAN. *J. Chem. Phys.*, **20**, 541–9 (*April*, 1952).

It has been assumed that the potential energy barrier hindering rotation of chain molecules about their long axes in the solid state has one deep minimum and Ω other minima with a potential energy V above that of the deeper well. Molecular models suggest Ω should be between 8 and 18. Application of the Bragg–Williams co-operative approximation to this system leads to first-order thermal and dielectric transitions. Dielectric and thermal data on n-$C_{22}H_{45}Br$, n-$C_{30}H_{61}Br$ and n-$C_{28}H_{58}$ show that the transitions are first-order. The static dielectric constant of the polar compounds calculated from Onsager's equation on the basis $\Omega = 12$ agree closely with experiment. The model suggests the existence of two Debye type loss regions below the transition temperature. Loss data confirm this and further indicate Ω is close to 12. There is no evidence of resonance absorption. Ω may also be found from the entropy of transition at constant volume, $R \ln \Omega$. Thermal data on all three compounds are consistent with a value of Ω of 12. The theory indicates that the

transition temperatures of a homologous series should arise almost linearly with increasing chain length if the chains do not twist appreciably. Data from the literature confirm this. A.

539.11 : 548.7

5218. The cellular method of determining electronic wave functions and eigenvalues in crystals, with applications to sodium. D. J. HOWARTH AND H. JONES. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 355–68 (*May*, 1952).

The eigenvalues and wave functions for the conduction electrons in metallic sodium are calculated for various points of high symmetry in the Brillouin zone. The method adopted is an extension of that used by von der Lage and Bethe in which boundary conditions are applied at a large number of points on the surface of the atomic polyhedron. Eigenvalues are obtained for states whose wave vectors lie at the ends of the 2-fold, 3-fold and 4-fold axes. The energy gap at the centre of a face of the zone is found to be 0·65 eV. A method of testing the results, of a more general nature than the empty lattice test of Shockley, is outlined and applied to certain cases. A.

MOLECULAR STRUCTURE 539.13

539.132

5219. Quantum theory of the N_2-molecule. I. Posing of the problem and bases of the investigations to be carried out. The N_2 molecule as 6-electron problem. H.-J. KOPINECK. *Z. Naturforsch.*, **7a**, 22–33 (*Jan.*, 1952) *In German.*

The $^1\Sigma_g^+$ ground state is determined using Slater's theory of localized valences. It is not permissible to ignore 1*s*- and 2*s*-electrons as this leads to dissociation energy 7·55 eV (expt. 9·76) and internuclear distance 1·196 Å (1·095 Å). Calculations show that permutations higher than transpositions may be ignored in *H* and *E* integrals. J. JACOBS

539.132

5220. The theory of characteristic frequencies and certain of its applications. L. S. MAYANTS. *Trudy Fizicheskogo Instituta P.N. Lebedeva, Vol.* 5, *Moscow, Akademii Nauk SSSR* (1950) *pp.* 63–183.

Doctorate thesis presented at the Lebedev Physical Institute.

539.132

5221. Molecular force fields. XIII. The potential energy function of the hydrogen cyanide molecule. W. BROOKS. *Trans Faraday Soc.*, **47**, 1152–7 (*Nov.*, 1951).

For Pt XII, see Abstr. 4245 (1950). Heath and Linnett have calculated some of the anharmonicity terms to be associated with the bonds of the water molecule [Abstr. 3993 (1948)]. A similar calculation for HCN requires certain simplifying assumptions. The values of the cubic and quartic terms associated with change of length of the CN bond appear to be abnormal, but the CH bond constants are very similar to those of CH diatomic radicals. A.

539.132

5222. The dissociation energies of some oxygen-halogen bonds. E. GELLES. *Trans Faraday Soc.*, **47**, 1158–60 (*Nov.*, 1951).

The dissociation energies of the oxygen-halogen bonds in the molecules HOI, HOBr, HOCl have been calculated. They are 56, 56 and 60 kcal./mole at 298°K. A.

539.132

5223. A simple solution to the problem of the potential function and the normal co-ordinates for polyatomic molecules. M. LARNAUDIE. *C.R. Acad. Sci.* [*Paris*] **234**, 1150–2 (*March* 10, 1952) *In French.*

A method of calculating approximately the elements of the matrix of force and interaction constants of molecules from infrared and Raman data is described in detail. A. J. TAYLOR

539.132

5224. The mean amplitudes of thermal vibrations in polyatomic molecules. I. $CF_2 = CF_2$ and $CH_2 = CF_2$. Y. MORINO, K. KUCHITSU AND T. SHIMANOUCHI. *J. Chem. Phys.*, **20**, 726–33 (*April*, 1952).

A normal co-ordinate treatment based on the potential function of Urey–Bradley type has been applied to $CF_2 = CF_2$ and $CF_2 = CH_2$ molecules by taking into account the repulsions between non-bonded atoms in addition to the valence force field. The mean-square amplitudes of thermal vibration of the atomic distances in these molecules have been calculated by the use of the normal co-ordinates and compared with those obtained by I. Karle and J. Karle from the electron diffraction investigation. A.

539.132

5225. On the determination of rotational line half-widths of diatomic molecules. S. S. PENNER AND H. S. TSIEN. *J. Chem. Phys.*, **20**, 827–8 (*May*, 1952).

A simple closed-form expression is obtained for the fractional intensity of radiation absorbed by vibration-rotation bands with collision-broadened spectral lines. The resulting expressions greatly reduced the labour involved in obtaining apparent rotational half-widths from experimental measurements. A.

539.132 : 535.371

5226. The "α"-band of formaldehyde and the relation between the ultraviolet absorption and fluorescence systems. P. J. DYNE. *J. Chem. Phys.*, **20**, 811–18 (*May*, 1952).

A fine-structure analysis is presented of part of the "α"-band of formaldehyde which lies at λ3700. It is shown that the "α"-band and the "*A*" band which lies at λ3530 have neither the upper nor the lower state in common. It is also shown that the lower state of the "α"-band is one in which one quantum of the antisymmetric vibration ν_6'' is excited. The vibrational structure of the fluorescence system is discussed in the light of these results. A.

539.132

5227. Effect of polar solvents on the absorption frequency of $n \rightarrow \pi$ electronic transitions. H. MCCONNELL. *J. Chem. Phys.*, **20**, 700–3 (*April*, 1952).

A variety of spectroscopic data shows that the absorption frequencies of $n \rightarrow \pi$ electronic transitions

rogressively increase in the series of solvents, araffin, alcohol and water. This general effect of olar solvents on the frequency of $n \rightarrow \pi$ transitions l related to the characteristic change in the molecular arge distribution accompanying this type of transi- on. In certain cases solvation effects can be of onsiderable value in distinguishing between $n \rightarrow \pi$ nd $\pi \rightarrow \pi$ electronic transitions. Evidence is resented which indicates that the absorption bands f the ions, NO_3^- (32 000 cm^{-1}), $CO_3^=$ (46 000 cm^{-1}) nd $CS_3^=$ (20 000 cm^{-1}) are $n \rightarrow \pi$ transitions. A.

539.132

5228. On the lifetime of the lower triplet states of enzene. M. MIZUSHIMA AND S. KOIDE. *J. Chem. hys.*, **20**, 765–9 (*May*, 1952).

Transition probabilities and selection rules are alculated for the lower triplet-singlet transitions of enzene. The relativistic spin-orbit coupling term ombines the triplet state with an intermediate singlet tate, and then dipole transition to the ground state ccurs. The selection rules are deduced group- heoretically, and the transition probabilities are alculated using the LCAO one-electron approxima- ion. The effect of vibration is discussed. The heoretical results obtained agree with Shull's and McClure's experimental results. A.

539.132

5229. Coupling of electronic and nuclear motion in nolecules and crystals. M. BORN. *Nachr. Wiss. Göttingen, Math.-phys. Kl. IIa, No.* 6, 3 *pp.* (1951) *In German.*

In order to eliminate electron motion, an adiabatic approximation can be used such that the mean nuclear position X_k^0 remains arbitrary throughout. J. JACOBS

539.132

5230. The pure nuclear electric quadrupole resonance of N^{14} in three molecular solids [ICN, BrCN and $(CH_2)_6N_4$]. G. D. WATKINS AND R. V. POUND. Letter in *Phys. Rev.*, **85**, 1062 (*March* 15, 1952).

539.132

5231. The influence of first-order rotational resonance interaction on certain bands in the infrared spectrum of the allene molecule. J. DE HEER. *J. Chem. Phys.*, **20**, 637–41 (*April*, 1952).

The Coriolis coupling between two degenerate vibrations in allene has been discussed. This theoretical treatment gives a satisfactory explanation of the main features of two perpendicular bands, which have been observed in the infrared absorption spectrum of this molecule between 8 and 14 μ. An analysis of the nuclear spin statistics has been carried out in order to account for the intensity alternations and to help in identifying the Q branches. A derivation of the frequency formula has been given on the basis of ordinary first order perturbation theory. Some emphasis is laid on the ambiguity in notation and the relation of this formula to others, reported in the literature. After making some reasonable assumptions with regard to the geometry of the molecule, numerical values have been obtained for the band centres and the various Coriolis coupling coefficients. A tentative suggestion has been made in partial explanation for the appearance of satellites between the main Q branches in the spectrum. A.

539.132

5232. The sign of the quadrupole interaction energy in diatomic molecules. R. A. LOGAN, R. E. COTÉ AND P. KUSCH. *Phys. Rev.*, **86**, 280–7 (*May* 1, 1952).

The molecular beam magnetic resonance method has been used to determine the sign (and the magnitude in those cases where it has not been previously measured) of the quadrupole interaction energy of the alkali nuclei in the homonuclear molecules, that of Na^{23} and Li^7 in the alkali halides, and that of Cl^{35} and Cl^{37} in KCl. An obstacle is inserted into the path of the beam so that its edge coincides with the position of the undeflected beam. Molecules of either positive or negative total magnetic moment are then removed from the beam which arrives at the detector. Certain maxima in the nuclear resonance spectrum at high magnetic fields ($eqQ \ll g_I\mu_0 H$) arising from the transitions $\Delta m_I = \pm 1$ are suppressed depending on the states removed by the obstacle. It is thus possible to identify the resonance maxima in terms of the transitions which produce them. From this evidence the sign of the quadrupole interaction energy can be deduced. The quadrupole interaction energy, eqQ, is positive for Li^7 and negative for Na^{23} in the homonuclear and the halide molecules. These results suggest that the sign of q at a given nucleus is the same in a rather considerable range of diatomic molecules. The interaction constant, eqQ, is positive for Cs^{133} in Cs_2, and negative for K^{39} in K_2, Rb^{85}, Rb^{87} in Rb_2 and Cl^{35}, Cl^{37} in KCl. The signs of the interaction for K^{39}, Rb^{85}, Rb^{87}, and Cs^{133} in the alkali fluorides, and for Cl^{35}, Cl^{37} in TlCl as determined by the molecular beam electrical resonance method are the same as those for the same nucleus in the molecules here considered. A.

539.132

5233. The use of 3*d* orbitals in certain valency states of the carbon atom and other first-row elements. R. J. GILLESPIE. *J. Chem. Soc.* (1952) 1002–13 (*March*).

The possibility that carbon and nitrogen utilize their 3*d* orbitals in bond formation in certain molecules is discussed. The conditions are considered under which higher valency states involving these orbitals are formed and it is shown that the promotional energies involved are probably not prohibitively large. On the basis of the assumption that carbon can utilize one or more of its 3*d* orbitals for bond formation under suitable circumstances, the transition state of a bimolecular substitution reaction at a saturated carbon atom, the transition state of a carbonium ion rearrangement, and the electronic structure of certain metal alkyls are discussed in detail. The possibility that other first-row elements also utilize their 3*d* orbitals in bond formation is also briefly considered. A.

539.132

5234. Spin-orbit interaction in aromatic molecules. D. S. MCCLURE. *J. Chem. Phys.*, **20**, 682–6 (*April*, 1952).

The matrix elements of spin-orbit interaction are obtained for polyatomic molecules using M.O. wave functions, taking account of configurational interaction. These results are then applied to the calculation of singlet-triplet transition probabilities in

aromatic compounds. It is shown without evaluation of integrals that intercombination transitions in these compounds should be much weaker than in most other classes of organic compounds. This is in agreement with experimental results on the phosphorescence life-times of these compounds. A.

539.132

5235. A molecular orbital theory of reactivity in aromatic hydrocarbons. K. Fukui, T. Yonezawa and H. Shingu. *J. Chem. Phys.*, **20**, 722–6 (*April*, 1952).

In the search for a quantitative correlation between reactivity and electronic configuration of aromatic hydrocarbons, the electron density, at each carbon atom, of the highest occupied π-orbital in the ground state of the molecule is calculated by means of the LCAO method. Comparing the result of such a calculation on fifteen condensed aromatic hydrocarbons with their chemical reactivities, it is found that the position at which the electron density is largest is most readily attacked by electrophilic or oxidizing reagents. It is, therefore, concluded that distinct from other π-electrons the pair of π-electrons occupying the highest orbital, which is referred to as *frontier* electrons, plays a decisive role in chemical activation of these hydrocarbon molecules. The theoretical significance of this discrimination of the frontier electrons in relation to the chemical activation is discussed. A.

539.132 : 535.343

5236. The spectra and electronic structure of the tetrahedral ions MnO_4^-, CrO_4^{--}, and ClO_4^-. M. Wolfsberg and L. Helmholz. *J. Chem. Phys.*, **20**, 837–43 (*May*, 1952).

A semiempirical treatment was used to calculate the energies of the molecular orbitals for the ground state and the first few excited states of permanganate, chromate and perchlorate ions. The calculation of the excitation energies is in agreement with the qualitative features of the observed spectra, i.e., absorption in the far ultraviolet for ClO_4^-, two strong maxima in the visible or near ultraviolet for MnO_4^- and $CrO_4^=$ with the chromate spectrum displaced toward higher energies. An approximate calculation of the relative *f*-values for the first transitions in $CrO_4^=$ and MnO_4^- is also in agreement with experiment. The data on the absorption spectra of permanganate ion in different crystalline fields is interpreted in terms of the symmetries of the excited states predicted by the calculations. A.

539.132 : 541.127

5237. Theoretical considerations concerning Hammett's equation. II. Calculation of σ-values for toluene and naphthalene. H. H. Jaffé. *J. Chem. Phys.*, **20**, 778–80 (*May*, 1952).

For Pt 1, see Abstr. 4517 (1952). The electron distributions in toluene and naphthalene are calculated by the LCAO MO method. The Coulomb integrals of the methyl carbon atom in toluene and the central atoms in naphthalene are assigned small increments which are justified by qualitative reasoning. These increments are treated as empirical parameters and adjusted to give the best correlation between electron densities and Hammett's σ-values. The parameters so derived are shown to obey the expected qualitative relations and lead to a good correlation of electron densities and σ-values.

539.133

5238. Disproportionation in deuterated ammonia. D. F. Stedman. *J. Chem. Phys.*, **20**, 718–21 (*April*, 1952).

Infrared absorption spectra indicate that in NH_3 containing equal molar proportions of D and H, the proportions of the various molecular species appear to depart very seriously from what would be expected if all configurations are intrinsically equally probable. A.

539.133 : 535.343–14

The microwave spectra and molecular structures of trifluoromethyl bromide, iodide and cyanide. *See Abstr.* 5010.

539.133 : 535.343–14

The microwave spectra of ketene. *See Abstr.* 5011

539.133 : 535.343–14

The microwave spectra and molecular structures of methyl bromoacetylene and methyl iodoacetylene. *See Abstr.* 5012

539.133 : 535.375.5

5239. Molecular analysis by the method of combination scattering of light. M. M. Sushchinskii. *Trudy Fizicheskogo Instituta P.N. Lebedeva, Vol. 5, Moscow, Akademii Nauk, SSSR* (1950) *pp.* 185–260.

Doctorate thesis presented at the Lebedev Physical Institute.

539.133 : 535.56 : 541.65

5240. The absolute configuration of optically active molecules. W. W. Wood, W. Fickett and J. G. Kirkwood. *J. Chem. Phys.*, **20**, 561–7 (*April*, 1952).

The problem of the absolute configuration of optically active molecules is investigated with the aid of the Kirkwood theory of optical rotatory power. Absolute configurations are assigned to the enantiomorphs of 2,3-epoxybutane and 1,2-dichloropropane. The assignments are consistent with the established experimental configurational relationships between these compounds. The Fischer convention is confirmed as a structurally correct representation of absolute configuration. The magnitudes of the calculated rotations of the compounds are in reasonably good agreement with experiment. The theory accounts satisfactorily for the effect of temperature and solvent on the optical rotation of 1,2-dichloropropane. A.

539.133

5241. An attempt to interpret the infrared spectra of metallic acetyl acetonates. C. Duval, R. Freymann and J. Lecomte. *Bull. Soc. Chim. France*, **19**, 106–13 (*Jan.–Feb.*, 1952) *In French.*

Absence of the characteristic C = O band (*circa* 1720 cm^{-1}) with further supporting data, suggests the possibility of a cyclic configuration in which the metal atom, being bonded to the two oxygen atoms, forms part of the ring structure. H. H. Greenwood

539.133

5242. Theoretical determination of the electron distribution in benzene by the Thomas–Fermi and the molecular-orbital methods. N. H. March. *Acta Cryst.*, **5**, 187–93 (*March*, 1952).

The results of theoretical calculations of the electron

distribution in benzene are reported. Density contours, both in the plane of the benzene ring and in a parallel plane at a height of 0·35 Å above the ring, are given for the Thomas–Fermi and the molecular-orbital methods. It is shown that in the molecular-orbital method the π electrons have only a small influence on the density in the parallel plane, except immediately above the C atoms, where they contribute about half of the total density. As far as comparison is valid the results appear to be in reasonable agreement with X-ray results of Robertson and his co-workers for naphthalene. A.

539.133

5243. The molecular structure of 1,2-dichloropropane. W. W. Wood and V. Schomaker. *J. Chem. Phys.*, **20**, 555–60 (*April*, 1952).

Under the assumption of $V(\phi)=V_0[1-\cos(\phi-\phi_0)]/2$ for the potential hindering internal rotation, visual interpretation of the electron-diffraction pattern leads to the results (best values and estimated limits of error): C − Cl, 1·79 ± 0·035 Å; C . . . Cl, 2·715 ± 0·025 Å; C − C, 1·56 Å (range: 1·49–1·60 Å); ∠ C − C − Cl, 108 ± 4°; $|\phi_0| \leqslant 30°$ (i.e., essentially *trans* in the chlorine atoms), with a small positive value of ϕ_0 (increasing $CH_3 \ldots Cl_{primary}$) most likely; $V_0 \geqslant 4$ kcal/mole. The best value for V_0 ranges from 10 kcal/mole for $\phi_0 = 0°$ to 30–40 kcal/mole for $\phi_0 = 25°$. The diffraction pattern is almost indifferently compatible with fractions ranging up to 50% of a *skew* isomer with $\phi_0 \sim 120°$ and a sufficiently low value of V_0, but consideration of dipole moment data provides some further evidence on its structure while showing the fraction present to be about 20% with an upper limit of about 30%. A.

539.133 : 535.343–14

5244. Microwave spectra and molecular structures of fluoroform, chloroform, and methyl chloroform. S. N. Ghosh, R. Trambarulo and W. Gordy. *J. Chem. Phys.*, **20**, 605–6 (*April*, 1952).

Sufficient isotopic combinations have been studied to make complete structural determinations of fluoroform and chloroform from microwave rotational spectra. The dimensions of CHF_3 are $d_{CH} = 1·098$ Å, $d_{CF} = 1·332$ Å and ∠ FCF = 108°48′; those of $CHCl_3$ are $d_{CH} = 1·073$ Å, $d_{CCl} = 1·767$ Å, and ∠ClCCl = 110°24′. Measurements were made on only the most abundant isotopic species of CH_3CCl_3. If the CCl_3 configuration as in chloroform and the CH_3 configuration as in methane are assumed, the CC distance in CH_3CCl_3 is found to be 1·55 Å. A.

539.133 : 535.343.2–15

5245. Polarized infrared radiation in the study of the molecular structure of substituted nitrobenzenes. R. J. Francel. *J. Amer. Chem. Soc.*, **74**, 1265–8 (*March* 5, 1952).

Infrared spectra are presented for five ortho-substituted nitrobenzene compounds in the solid phase using polarized radiation and linearly oriented preparations. The molecular structure of these compounds is interpreted on the basis of known vibrational assignments of certain absorption bands and the behaviour of these bands toward polarized infrared radiation. *o*-Nitrophenol, 2-nitroresorcinol and *o*-nitroaniline are found to be planar molecules, while *o*-nitrobromobenzene and *o*-nitrochlorobenzene are found to be non-planar.

539.133 : 537.533.73 : 535.42

5246. Analogies between the diffraction of light and electron diffraction by gas molecules. L. Bru, M. P. Rodriguez and R. Vega. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 249–55 (*April*, 1952).

Monochromatic light has been diffracted by a unit formed by an ensemble of slits with a common axis, in which all periodicities which a molecule can exhibit are represented. By a suitable choice of the slit areas, moreover, the contribution to the expression of the intensity of each of these periodicities can be taken account of. Analysis leads to expressions similar to those used in the interpretation of the pattern obtained in electron diffraction by gases. These have been applied to the cases of benzene and carbon tetrachloride. The positions of the diffraction maxima and minima agree to within little more than 1% with those of the corresponding electron diffraction patterns Values found for interatomic distances (starting from the relative formula of radial distribution) also agree with the real ones within the foregoing limit. A.

539.133 : 541.553

Directed valence in P_4 and As_4. *See Abstr.* 5405

539.133 : 548.736.4

5247. The structure of chlorine hydrate. L. Pauling and R. E. Marsh. *Proc. Nat. Acad. Sci.* [*Wash.*] **28**, 112–18 (*Feb.*, 1952).

A structure is proposed suitable for hydrates of small gas molecules, based on the O_h^3 group. The unit cell contains 46 H_2O molecules, the O atoms forming 2 pentagonal dodecahedra and 6 tetrakaidecahedra. For the chlorine hydrate this leads to the formula $Cl_2 . 7\frac{2}{3} H_2O$; for slightly smaller molecules, which could occupy all polyhedra the formula is $M . 5\frac{3}{4} H_2O$. J. JACOBS

539.133

5248. The electric dipole moments in the homologue series of 4 . 4′-di-*n*-alkoxy–azoxy benzenes. W. Maier and G. Baumgartner. *Z. Naturforsch.*, **7a**, 172–5 (*Feb.*, 1952) *In German.*

Dipole moments of trans-isomers were measured in benzene solution, as these have liquid-crystaline phases. The alternation of high and low dielectric anisotropy is not repeated in dipole moments. J. JACOBS

539.133

5249. The measurement of bond moments and derivatives in HCN and DCN from infrared intensities. G. E. Hyde and D. F. Hornig. *J. Chem. Phys.*, **20**, 647–52 (*April*, 1952).

The absolute i.r. absorption intensities of the fundamental vibrations of HCN and DCN were measured, using the pressure broadening technique. These measurements yield the bond moments $\mu_{C-H} = \pm 1·13$d, $\mu_{C\equiv N} = \pm 1·80$d and show that if C is positive in the C ≡ N dipole, H is positive in the C − H dipole. The change in moment with internuclear distance is found to be $\partial\mu/\partial r_{C-H} = \pm 1·05$d/A, $\partial\mu/\partial r_{C\equiv N} = \mp 0·66$d/A. Two of the three anomalous peaks in the band ν_1 of HCN are shown to arise from the dimer of HCN. A.

539.133

5250. Polarizability model of effective charges. F. Matossi. *J. Chem. Phys.*, **20**, 819–21 (*May*, 1952).

The effective charge $d\mu/dr$ (μ = dipole moment, r = interatomic distance) is computed for linear diatomic and triatomic molecules from an expression for μ which includes the effect of induced atomic dipoles. Agreement with observation is possible only if the atomic polarizabilities α are considered to be variable with r. $\alpha' = d\alpha/dr$ is obtained in good numerical agreement with values previously derived from Raman effect data. Thus, a reasonably consistent classical picture can be established that covers dipole moments, infrared intensities, and Raman line depolarization factors. A.

539.133

5251. Statistical mechanics of rubber. F. W. Boggs. *J. Chem. Phys.*, **20**, 632–6 (*April*, 1952).

It is shown that above the second-order transition the partition function of a rubber can be represented to a reasonably good approximation by the product of the partition function of a liquid formed of molecules similar to the chain elements and the partition function of the noninteracting chains divided by the partition function of a perfect gas. In terms of the free energy this means that the free energy of rubber will be equal to the sum of the free energy of the chain network without interactions and that of a liquid formed of the chain elements alone minus the free energy of a perfect gas having the same number of molecules as the rubber has chain elements. This same procedure has permitted the calculation of the free energy and partial pressure of a rubber solution. This is, however, by no means the only possible application. All the thermodynamic properties of elastomer solvent systems can be obtained. This is a generalization of the methods previously used in the statistical studies of rubber and rubber solvent mixtures. A.

539.133

5252. Dimensions of polybutadiene-type molecules. H. Markovitz. *J. Chem. Phys.*, **20**, 868–72 (*May*, 1952).

The calculation of root-mean-square end-to-end distances (R_p) is carried out for polybutadiene-type molecules. A table and graphs are given for this dimension as a function of the fraction of 1, 2 and 1, 4 addition and the percentage *cis*- and *trans*-configuration about the double bonds remaining in the chain. Also the root-mean-square radius of gyration (R_g) for molecules with all 1, 4 addition has been calculated. It is found that $R_p^2 = 6R_g^2$ as is true for polymer molecules all of whose bonds can rotate completely freely and for those molecules where freely rotating bonds maintain fixed valence angles. Free rotation about the single bonds, a linear chain, no volume exclusion effect, and a polymer molecule with many monomer units are assumed. A.

539.133 : 537.226

5253. A new type of disorder affecting the dielectric properties of long-chain esters. R. W. Crowe, J. D. Hoffman and C. P. Smyth. *J. Chem. Phys.*, **20**, 550–4 (*April*, 1952).

The dielectric properties of a series of long-chain esters have been investigated in the solid state. Like other long-chain molecules containing 20 or more carbon atoms, most of the ester molecules showed evidence of hindered molecular rotation about their long axes in the crystal lattice. It was also found that higher dielectric constants resulted when the samples were rapidly frozen than when they were allowed to solidify gradually, the effect being more pronounced as the chain length was increased. In order to explain this behaviour, it has been assumed that the esters may crystallize in an ordered lattice in which the dipoles are in a plane, or in a longitudinally disordered lattice in which some of the chains are reversed. In the latter case, the dipoles may or may not form two planes depending upon the position of the polar group in the chain. It has also been assumed that the degree of longitudinal disorder increases with increase in freezing rate. Once frozen in, however, it remains fixed until the sample is remelted. The potential barrier hindering rotation has been assumed to be much higher in the ordered state than in the disordered state because separation of the dipoles should lower steric and dipole interaction in the latter. Since the rotational transition temperature is proportional to a potential energy difference V_0 related to the barrier against rotation, the transition temperature should increase with increase in longitudinal order. In a completely ordered ester or a nearly symmetrical disordered ester, the barrier may be sufficiently high to raise the transition point to a temperature near or above that of fusion. The experiments agree with these assumptions. A.

539.133 : 548.737

5254. The external form of the haemoglobin molecule. I. W. L. Bragg and M. F. Perutz. *Acta Cryst.*, **5**, 277–83 (*March*, 1952).

When a salt solution is substituted for water as the medium surrounding a haemoglobin crystal, a few spots of low order are reduced in intensity, while high orders are little affected. The salt enters the liquid surrounding the molecules in the crystal, reducing the contrast in density between protein and liquid. Absolute measurements of the changes in $|F|$ values are used to determine the approximate outer form of the hydrated haemoglobin molecule which is not penetrated by the salt. It is concluded that its width is about 55 Å in the *b* and *c* directions, and its length about 65 or 80 Å in the *a* direction. Its volume is approximately 116 000 Å^3. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

5255. Meson theory and spin-orbit coupling in the nucleus. H. Gaus. *Z. Naturforsch.*, **7a**, 44–55 (*Jan.*, 1952) *In German.*

The neutral vector meson theory gives, without regard to exchange effects, a strong spin-orbit coupling for the motion of a nucleon in a nucleus, analogous to the motion of a magnet in an electric field. With the help of the Hartree–Fock equations, exchange effects can also be represented as the action of an effective

otential well where in particular the vector theory harged or symmetric) again leads to spin-orbit oupling. In view of recent experiments indicating in zero for π-mesons the possibility of spin-orbit oupling also in this case is demonstrated; in the s. scalar case it is necessary to extend the perturbaon treatment to higher orders. W. J. SWIATECKI

539.152.1

256. The closing of the proton sub-shell at Z 58. P. DUBE AND S. JHA. Letter in *Phys. Rev.*, **85**, 042 (*March* 15, 1952).

The evidence for sub-shells in addition to the magic numbers 2, 8, 20, 28, 50, 82 and 126 is discussed and evidence for the closing of the $1g_{7/2}$ shell at $Z = 58$ making $_{58}Ce^{140}$ doubly magic) is obtained from the sudden drop in the binding energy of the 59th proton reduced from neutron binding energies and β-decay data. W. J. SWIATECKI

539.152.1

257. A proposed test of the nuclear shell model. H. A. BETHE AND S. T. BUTLER. Letter in *Phys. Rev.*, **85**, 1045–6 (*March* 15, 1952).

Some examples of stripping reactions are discussed whose angular distribution should give direct information on the accuracy of the independent particle model of nuclear structure. L. PINCHERLE

539.152.1

258. The range of tensor forces in the deuteron ground state. D. G. PADFIELD. *Proc. Phys. Soc. [Lond.] A*, **65**, 309–20 (*May*, 1952).

A set of nuclear parameters (ranges and depths of potential wells) yielding the established values of the binding energy, quadrupole moment and magnetic moment of the deuteron, and consistent with the other experimental data relevant to the ground state of the neutron–proton system has been found. A.

539.152.2

259. Electromagnetic effects due to spin-orbit coupling. J. H. D. JENSEN AND M. G. MAYER. Letter in *Phys. Rev.*, **85**, 1059 (*March* 15, 1952).

The existence of strong spin-orbit coupling implies an interaction of charged nucleons with external magnetic fields. The effect produces deviations of the magnetic moments of nuclei from the Schmidt lines but is too small to explain the observed deviations. Other consequences are additional radiative transition probabilities, important when the ordinary ones vanish. W. J. SWIATECKI

539.152.2

260. The nuclear magnetic moment of $^{197}_{79}$Au. F. M. KELLY. *Proc. Phys. Soc. [Lond.] A*, **65**, 250–4 (*April*, 1952).

The hyperfine structure of the 6*s* and 7*s* levels of Au I have been measured. The values of the nuclear magnetic moments calculated from the structure of these two levels using the Goudsmit–Fermi–Segrè formula agree. Since the Fermi–Segrè factor is very large (1·424) for the 6*s* level and small (1·038) for the 7*s* level, this affords a good check on the validity of the method introduced by Crawford and Schawlow for the evaluation of this factor. When the corrections for the finite size of the nucleus are included, the spectroscopic value of the nuclear magnetic moment of Au^{197} is $+0{\cdot}136$ n.m. A.

539.153

5261. Resonance-exchange of ions in slow collisions. O. B. FIRSOV. *Zh. Eksper. Teor. Fiz.*, **21**, 1001–8 (*No.* 9, 1951) *In Russian.*

Using adiabatic approximation a formula is developed for the case when the atom and its ion are in an *S*-state. From the experimental relation between resonance-exchange and ion velocity the binding energy of an electron in a negatively charged ion of alkaline metals is determined. A comparison of experimental and theoretical cross-sections of exchange of positively charged ions of He^+ and Hg^+ is given. J. JACOBS

539.153

5262. The exchange integral in the 3*d* shell. H. KAPLAN. Letter in *Phys. Rev.*, **85**, 1038 (*March* 15, 1952).

The Heitler–London exchange integral J was calculated as a function of the separation between 2 atoms each having one 3*d* electron, using Bartlett's method. The positive sign of the result supports Heisenberg's theory of ferromagnetism. W. J. SWIATECKI

539.153

5263. The effects of configuration interaction on the atomic hyperfine structure of gallium. G. F. KOSTER. *Phys. Rev.*, **86**, 148–54 (*April* 15, 1952).

The effects on the hyperfine structure of the mixing of higher configurations with the ground configuration $(4s)^2 4p$ of Ga is studied. It is found that the only configuration which need be considered is the $4s4p5s$. A Hartree wave function for the excited 5*s*-state of Ga is calculated, and the extent of the mixing of this excited configuration with the ground configuration is determined. The coupling constants for magnetic and electric quadrupole hyperfine structure are computed with the use of the wave function for the ground state of Ga including the excited configuration. The determination of quadrupole moments from atomic hyperfine structure measurements is discussed and various methods of making this calculation compared. Beside the determination of the quadrupole moments of Ga, the quadrupole moments of Al, In and Cl are estimated. A.

539.153

5264. Effect of the atomic core on the magnetic hyperfine structure. R. STERNHEIMER. *Phys. Rev.*, **86**, 316–24 (*May* 1, 1952).

Equations have been obtained for the magnetic field at the nucleus due to the current induced in the electron core by an external valence electron. The magnetic field is written as $-4\mu_0[j/(j(j+1))]\langle r^{-3}\rangle_p(1+R_m)$, where $\langle r^{-3}\rangle_p$ is the average over the valence electron function, assumed in a p state, R_m is the correction due to the core, μ_0 = Bohr magneton, j = angular momentum. R_m is of importance in obtaining the nuclear quadrupole moment Q from the value of the magnetic moment μ_I and the ratio b/a of the splittings due to Q and μ_I. The electric field gradient at the nucleus, $-\frac{2}{3}e\langle r^{-3}\rangle_p(1+R)$, which determines b, contains a similar term R for the distortion of the core by the valence electron. It is shown that R_m approximately cancels the exchange terms of R, so

that the correction factor for Q is that predicted by the Thomas–Fermi model. A.

539.153.4

5265. Hydrogenlike atom in quantized space (non-relativistic theory). P. KARD. Letter in *Zh. Eksper. Teor. Fiz.*, **20**, 1144–5 (*No.* 12, 1950) *In Russian.*

A modification of Schrödinger's equation in momentum space, leading to quantization of the centrally symmetric field. Corrections of the Balmer levels are small. J. JACOBS

539.153.4

5266. $(n + l)$ groups in consecutive filling of electron configurations in atoms. V. M. KLECHKOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **80**, 603–6 (*No.* 4, 1951) *In Russian.*

The filling of electron levels in atoms takes place in groups of increasing $(n + l)$ value (n, principal, l, orbital quantum number). There are subgroups such that small n, large l, is filled first, ending with larger n, small l. A far-reaching analogy with the periodic system is established. J. JACOBS

539.153.4

5267. Electron-electron interaction in heavy atoms. G. E. BROWN. *Phil. Mag.*, **43**, 467–71 (*April*, 1952).

A Hamiltonian describing the e^2 interaction of two fast-moving electrons in a heavy atom is derived from quantum electrodynamics, the large electron–nucleus interaction being taken into account exactly.

R. H. DALITZ

539.153.4

5268. Electrodynamic displacement of atomic energy levels. II. Lamb shift. R. KARPLUS, A. KLEIN AND J. SCHWINGER. *Phys. Rev.*, **86**, 288–301 (*May* 1, 1952).

For Pt I, see Abstr. 4542 (1952). The vacuum fluctuations of the photon and pair fields modify the interaction of an electron with an electromagnetic field. The effects on the energy levels are conveniently described in terms of the mass operator and the vacuum polarization potential. An operator calculus for handling the mass operator is used to separate the contribution of low energy quanta, for which the external electromagnetic field may not be treated as weak. The remainder is given as a power series in the field. The additional displacement of order $Z\alpha$ with respect to the published values for the Lamb shift is calculated by specializing the external field to the Coulomb field of the nucleus and by taking the matrix element of the operators in an S-state of a hydrogen-like atom. It is found that the nS-level is raised by

$$\frac{Z^5\alpha^4}{n^3}\,\mathrm{Ry}\left(1 + \frac{11}{128} - \frac{1}{2}\ln 2 + \frac{5}{192}\right).$$

The theoretical value for the Lamb shift of an atom with infinitely heavy nucleus becomes 1058·42 Mc/s. Effects of finite nuclear mass and size change this value to 1057·8 Mc/s and 1058·9 Mc/s for H and D respectively. A.

539.154.2

5269. The periodic law in mathematical form. R. HAKALA. *J. Phys. Chem.*, **56**, 178–81 (*Feb.*, 1952).

539.154.3 : 548.7

5270. The atomic magnetic moments and the crystal structures of ferromagnetic metals and alloys. F. M. GALPERIN. *Zh. Eksper. Teor. Fiz.*, **21**, 1146–52 (*No.* 10, 1951) *In Russian.*

For solid solutions of Mn, Cr and V in Ni and of Cr and V in Fe the observed magnetic moments are compared with those calculated from the formula used previously [Abstr. 6022 (1950)]. Agreement to better than 1% is found in most cases. The ordered alloy MnBi (having a nickel arsenide structure) is also found to have a magnetic moment in fair agreement with that calculated. S. V. Vonsovskii has given a quantitative quantum-mechanical explanation of the formula in terms of the s–d exchange. A. L. MACKAY

539.155

5271. Masses of Pb^{208}, Th^{232}, U^{234} U^{235} and U^{238}. G. S. STANFORD, H. E. DUCKWORTH, B. G. HOGG AND J. S. GEIGER. Letter in *Phys. Rev.*, **85**, 1039 (*March* 15, 1952).

A mass spectrograph was used. The results have been combined with disintegration data to give mutually consistent values. T. G. PICKAVANCE

539.155

5272. Atomic masses from titanium through zinc. T. L. COLLINS, A. O. NIER AND W. H. JOHNSON, JR. *Phys. Rev.*, **86**, 408–12 (*May* 1, 1952).

The double-focusing mass spectrometer previously described [Abstr. 4621 (1951)] was used to measure 27 atomic masses in the region from titanium to zinc. When supplemented by the earlier values and nuclear reaction energies the data gives the masses of 81 nuclides between mass numbers 31 and 70. A fit of the semi-empirical mass formula of Wigner indicates the existence of magic numbers at 20 and 28 protons and neutrons associated with discontinuities in the binding energy surface. The discontinuities are primarily changes in slope of the surface. A.

539.155.2

5273. The isotopic constitution of igneous sulphur and the primordial abundance of the terrestrial sulphur isotopes. J. MACNAMARA, W. FLEMING, A. SZABO AND H. G. THODE. Note in *Canad. J. Chem.*, **30**, 73–6 (*Jan.*, 1952).

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.163.1

5274. The half-life of RaE. F. BEGEMANN AND F. G. HOUTERMANS. Note in *Z. Naturforsch.*, **7a**, 143–4 (*Jan.*, 1952) *In German.*

Activity measurements over 3 ½-lives on 2 samples of RaE purified in different ways (dithizon, electro-chemical deposition on Ni) in 2N acid solution in a liquid counter gave the ½-life 5·02 ± 0·02d.

A. O. STANESBY

539.163.1

5275. A measurement of the ½-life of Kr^{79}. P. RADVANYI. *C.R. Acad. Sci.* [*Paris*] **234**, 1275–7 (*March* 17, 1952) *In French.*

Kr was separated from powdered NaBr irradiated with 6-MeV deuterons [Br^{79} $(d, 2n)Kr^{79}$] and the

tivity followed over 6 ½-lives using an ionization amber and string electrometer. The ½-life was 4·5 ± 0·2) hr. A. O. STANESBY

539.163.2

276. A radioactive isomer of ^{166}Ho. F. D. S. UTEMENT. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 254–8 *April*, 1952).

Irradiation of Ho with pile neutrons produces, in ldition to 27-hr Ho^{166}, a new long-lived Ho isotope ith a half-life greater than 30 years. It is shown that cannot be Ho^{167} produced by neutron capture in o^{166}, nor Ho^{164} produced by a $(n, 2n)$ reaction. It is herefore probably an isomer of the 27-hr Ho^{166}. It ecays with emission of β-particle groups of energies ·18, 0·28 and 1·1 MeV, γ-rays of energies 0·830, ·725, 0·280, 0·212 and (weak) 0·095 MeV, and eak Er K X-rays. β–γ and γ–γ coincidence easurements have been made and a decay scheme ggested. A.

539.163.2

277. Disintegration scheme of I^{131}. R. E. BELL ND R. L. GRAHAM. *Phys. Rev.*, **86**, 212–18 (*April* 15, 952).

The radiations of I^{131} (8-day) have been studied in pair of lens beta-ray spectrometers placed end to end, ith coincidence counting of the focused radiations rom a single source. Coincidence beta-spectra are hown with end points at 608 ± 5 keV (87·2%), 35 ± 6 keV (9·3%), and 250 ± 7 keV (2·8%). A eak 812 ± 15 keV β-spectrum (0·7%) apparently eads to the 12-day isomer of X^{131}. Relative intensities f the 3 main β-components are obtained from gamma-ray measurements alone. All gamma-rays ave their multipolarities assigned on the basis of easured K-conversion coefficients and K/L ratios. consistent disintegration scheme is proposed which s an extension of that of Metzger and Deutsch. ingle-particle orbital assignments are made to the ower excited states of Xe^{131} which agree with shell heory. A.

539.163.2

5278. Radioisotopes of bromine. S. C. FULTZ AND M. L. POOL. *Phys. Rev.*, **86**, 347–50 (*May* 1, 1952).

Se metal enriched with Se^{7} was bombarded with 7·3-MeV protons. A new 17·2-hr activity in Br was observed and is assigned to Br^{76}. The radiations of Br^{83}, Br^{80}, Br^{77}, Br^{76} and Br^{75} have been examined by use of a 180° focusing spectrometer and coincidence methods. Br^{83} emits a simple negatron spectrum with a maximum energy of 0·94 ± 0·02 MeV. The ground state of Br^{80} emits a complex negatron spectrum with components: 1·97 ± 0·03 MeV (80%), 1·1 MeV (11%), 0·7 MeV (9%). The γ-rays of Br^{77} are associated with the K-capture process. The ground state of Br^{76} emits positrons having a complex spectrum with components 3·57 ± 0·07 MeV (46%), 1·7 MeV (10%), 1·1 MeV (11%), 0·8 MeV (14%), 0·6 MeV (19%). γ-rays identified with Br^{76} have energies of ·25, 0·33, 0·37, 0·42, 0·68, 0·75, 0·96 and 1·2 MeV. The ground state of Br^{75} decays by emission of positrons having a complex spectrum with components ·70 ± 0·02 MeV (46%), 0·8 MeV (20%), 0·6 MeV 15%), 0·3 MeV (19%). A.

539.164

5279. Evidence for K-shell ionization accompanying the alpha-decay of Po^{210}. W. C. BARBER AND R. H. HELM. *Phys. Rev.*, **86**, 275–80 (*May* 1, 1952).

The radiations of Po^{210} have been studied using NaI scintillation counters. In agreement with Grace, Allen, West and Halban, it is concluded that the soft electromagnetic component probably entirely consists of X-rays of Pb. The region from 25 keV to 2·5 MeV has been examined and, with the exception of the known γ-ray of 800 keV, no nuclear γ-rays were observed. The ratio of the number of K X-rays to the number of 800-keV γ-rays was measured as 0·134 ± 0·025 to 1. The K-shell internal conversion coefficient of the 800-keV transition has been reported as about 0·05, and hence the K X-ray intensity is too great to be explained by internal conversion alone. The residual X-rays are attributed to the process whereby the emission of the α-particle causes ionization of the atom. Comparison of the relative intensity of K X-rays and α-particles shows qualitative agreement with the probability of this ionization process as calculated by Migdal. A.

539.165 , 539.166

5280. Beta- and gamma-radiation of Al^{28}. H. T. MOTZ AND D. E. ALBURGER. *Phys. Rev.*, **86**, 165–7 (*April* 15, 1952).

The β- and γ-rays occurring in the decay of Al^{28} were measured by means of lens spectrometers using sources activated by the (n, γ) and (d, p) reactions on Al. The γ-ray has an energy of 1·782 ± 0·010 MeV and the β-ray end point is found to be 2·865 ± 0·010 MeV. The total disintegration energy is consistent with nuclear reaction Q-values linking Al^{28} and Si^{28}. It is shown that a discrepancy of 0·4 mMU in the Si^{28}–Al^{27} mass difference exists when reaction data is compared to mass spectroscopic values. A mass for Al^{27} of 26·990140 ± 0·000034 is proposed, based on Si^{28}, P^{31} and S^{32} as standards. A.

539.165.2

5281. The shapes of negative beta-spectra at the low energy end. H. M. SCHWARTZ. *Phys. Rev.*, **86**, 195–7 (*April* 15, 1952).

The disposition of the excess atomic binding energy liberated in a negative β-decay is of interest in connection with the shape of the low-energy end of the β-spectrum. Previous theoretical work points to the carrying away of this energy by the β-particle in most cases, with a resulting practical cutoff at the low end of the energy spectrum. However, the present approach in which the nuclear and atomic electron transitions are treated as a unified process, leads to the conclusion that to the first order that shape is practically unaffected. A possibility for experimental study of this question is pointed out. A.

539.166

5282. γ-rays of Cs^{134}. V. S. SHPINEL. Note in *Zh. Eksper Teor. Fiz.*, **21**, 853–5 (*No.* 7, 1951) *In Russian.*

A spectrum of 9 lines in general agreement with previous determinations was found by analysing with a β-spectrometer the photoelectrons released in Pb. A level scheme is given. W. J. SWIATECK

539.166

5283. Precision measurements of nuclear gamma-radiation by techniques of beta-spectroscopy. I. The spectrometer with two-directional focusing as a tool for precise gamma-measurements. A. HEDGRAN. *Ark. Fys.*, **5**, 1–27 (*Paper* 1, 1952).

A spectrometer previously described [Abstr. 8781 (1950)] has been modified for optimum performance. Details of adjustment procedure and of a source arrangement for internal or external conversion work are given. The estimated resolution is $\sim 0{\cdot}5\%$ width at half maximum in momentum. The magnetic field measuring system, accurate to ~ 1 in 10^4, is described.

J. J. WILKINS

539.166

5284. Precision measurements of nuclear gamma-radiation by techniques of beta-spectroscopy. II. Determination of calibration energy standards using gold^{198}, annihilation radiation and cobalt^{60}. D. LIND AND A. HEDGRAN. *Ark. Fys.*, **5**, 29–52 (*Paper* 2, 1952).

See preceding abstract. The spectrometer was used to measure the energy difference between Au^{198} γ-rays (assumed $411{\cdot}24 \pm 0{\cdot}10$ keV standard) and annihilation radiation, with a result $0{\cdot}55 \pm 0{\cdot}11$ keV less than expected. The Au^{198} γ-rays were checked (to $\pm 0{\cdot}4$ keV) by an absolute method and by comparison with the $1331{\cdot}8 \pm 1{\cdot}0$ keV Co^{60} γ-rays (see also abstract following). The Doppler broadening of annihilation radiation was measured. Corrections for electron straggling in the spectrometer converter are discussed.

J. J. WILKINS

539.166

5285. Precision measurements of nuclear gamma-radiation by techniques of beta-spectroscopy. III. Measurements of gamma-rays from lanthanum^{140}, sodium^{24}, ThC″ and gallium^{72}. A. HEDGRAN AND D. LIND. *Ark. Fys.*, **5**, 177–190 (*Paper* 13, 1952).

See preceding abstract. By comparisons with Co^{60} and ThC″ γ-rays the following γ-ray energies (keV) were determined: La^{140}, $328{\cdot}6 \pm 0{\cdot}3$, $486{\cdot}7 \pm 0{\cdot}4$, $815{\cdot}1 \pm 0{\cdot}7$, 1596 ± 2; Na^{24}, $1367{\cdot}9 \pm 1{\cdot}0$, $2753{\cdot}5 \pm 1{\cdot}0$; Ga^{72}, 2491 ± 20, 2508 ± 2 (doublet with intensity ratio 5/8). Comparisons of annihilation and Au^{198} radiations with the ThC″ 0·51 MeV γ-rays ($510{\cdot}84 \pm 0{\cdot}09$ keV standard) gave annihilation radiation $510{\cdot}91 \pm 0{\cdot}12$ keV; Au^{198}, $411{\cdot}75 \pm 0{\cdot}10$ keV. The Au^{198} result resolves the discrepancy mentioned in Pt II. Comparison of the Th*L* and Th*X* lines revealed a small non-linearity in the spectrometer.

J. J. WILKINS

539.166

5286. Energy determination of the Se^{77m} γ-ray. J. ORRING. *Ark. Fys.*, **4**, 469–70 (*Paper* 30, 1952).

A 9 mg/cm^2 Se powder layer was irradiated with neutrons from Li(*d*, *n*) before each measurement. A β-ray spectrometer with a mica window was used. The decay curve was obtained; the γ-ray energy was found to be 165 keV.

F. R. HOLT

539.166

5287. Study of γ- and X-rays emitted by protoactinium 231. M. RIOU. *C.R. Acad. Sci.* [*Paris*] **234**, 1157–9 (*March* 10, 1952) *In French.*

An absorption method was used, with a previously reported arrangement [Abstr. 7476 (1950)]. The intensities of radiations at about 300, 100, 27 and 15 keV were found. The radiations are further analysed and discussed.

F. R. HOLT

539.166

5288. The velocity of 170-MeV gamma-rays. D. LUCKEY AND J. W. WEIL. Letter in *Phys. Rev.*, **85**, 1060 (*March* 15, 1952).

A value $2{\cdot}974 \times 10^{10}$ cm/sec ($\pm 1\%$) was obtained by counting bremsstrahlung γ-rays in delayed coincidence with the initiating electrons.

J. J. WILKINS

539.166

5289. Radioactivity of $Eu^{152, 154}$. R. KATZ AND M. R. LEE. Letter in *Phys. Rev.*, **85**, 1038–9 (*March* 15, 1952).

Some γ's previously believed to be from Sm are attributed to Eu, using neutron-activated Sm in a β-ray spectrograph. They are, for Eu^{152}: 121·2, 243·8 and 343·8 keV, and for Eu^{154}: 122·4 keV.

F. R. HOLT

539.166.2

5290. Vibration-rotation spectra of atomic nuclei. V. E. GOLANT. *Zh. Eksper. Teor. Fiz.*, **21**, 780–7 (*No.* 7, 1951) *In Russian.*

The γ-emission of heavy nuclei under weak excitation energies is examined on the basis of the drop model. The γ-transition probabilities, which are accompanied by simultaneous changes in the rotation state of the nucleus, are determined; the interaction of nuclear vibration and rotation is shown to be insignificant.

J. JACOBS

539.166.2

5291. Augular distribution in resonant nuclear reactions. K. A. TER-MARTIROSYAN. *Zh. Eksper. Teor. Fiz.*, **21**, 894–9 (*No.* 8, 1951) *In Russian.*

Without the use of perturbation theory, formulae are derived for the augular distributions and correlations of successively emitted particles. The case when one of the particles is a γ-quantum is considered [see also Gardner, Abstr. 1973 (1950), 3753 (1951); Yang, Abstr. 1158 (1949)].

W. J. SWIATECKI

539.166.7

5292. Polarization of the 6·13-MeV gamma-rays emitted in the reaction $F^{19}(p, \alpha)O^{16*}(\gamma)O^{16}$. A. P. FRENCH AND J. O. NEWTON. Letter in *Phys. Rev.*, **85**, 1041 (*March* 15, 1952).

The direction of polarization, deduced from Compton scattering measurements, indicates electric octupole radiation.

J. J. WILKINS

539.166.74

5293. Multiple gamma-ray scattering in lead. J. O. ELLIOT, R. T. FARRAR, R. D. MYERS AND C. F. RAVILIOUS. Letter in *Phys. Rev.*, **85**, 1048 (*March* 15, 1952).

Using the general transport equation of Spencer and Fano, for the propagation of γ-rays through an infinite medium, calculations have been made, and checked against experimental scatter build-up factors. Scattering in Pb from a source of Co^{60} was measured with photographic film.

D. V. MABBS

539.166.83

5294. Consideration of the finite nuclear dimensions in the calculation of inner conversion coefficients. A. A. Sliv. *Zh. Eksper. Teor. Fiz.*, **21**, 770–4 (*No.* 7, 1951) *In Russian.*

Using the example of magnetic multipole radiation a method is developed of taking nuclear dimensions into account. For heavy atoms this proved significant. J. JACOBS

539.166.83

5295. The measurement of the In^{113*} conversion coefficient with a scintillation spectrometer. T. B. Cook, Jr and S. K. Haynes. *Phys. Rev.*, **86**, 190–5 (*April* 15, 1952).

The internal conversion coefficient of the 0·39-MeV isomeric transition of In^{113*} has been determined with a scintillation spectrometer by measurements which involve only gamma-gamma and electron-electron intensity comparisons. A value of $\alpha = 0{\cdot}55 \pm 0{\cdot}03$ is obtained for the total conversion coefficient of this transition. Thus the *K*-conversion coefficient is $0{\cdot}46 \pm 0{\cdot}03$ if one uses the *K* to *L* conversion ratio of $5{\cdot}4 \pm 0{\cdot}8$ as determined by Lawson and Cork. This value is in good agreement with the value of 0·47 which is obtained from Rose's tables for magnetic 2^4-pole radiation. A.

539.166.84

5296. A second γ-transition ($d_{\frac{3}{2}} \rightarrow s_{\frac{1}{2}}$) in Xe^{129m}. S. Thulin and I. Bergström. Letter in *Phys. Rev.*, **85**, 1055 (*March* 15, 1952).

A 40 keV γ-ray is reported, in cascade with the known 196-keV isomeric γ-ray. J. J. WILKINS

539.167.3

5297. Interchange of fission-product bromine with carrier bromine. A. F. Stehney and N. Sugarman. *J. Chem. Phys.*, **20**, 629–31 (*April*, 1952).

Experiments on the interchange of the fission products 2·4-hr Br^{83} and 55·6-sec Br^{87} with carrier bromine have been performed. Essentially the same degree of interchange is effected by the following chemical procedures: carrier added as BrO_3^- and reduced by H_2S, carrier added as BrO_3^- and reduced by excess carrier Br^-, and carrier added as Br^- to HCl and irradiated uranium metal dissolved. A.

539.167.3 : 539.172.4

5298. Pile-produced radioactive materials and their uses. W. J. Arroli. *Endeavour* [*Lond.*] **11**, 61–71 (*April*, 1952).

NUCLEAR REACTIONS 539.17

539.17

5299. The scientific work of the Atomic Energy Research Establishment. J. Cockcroft. *Proc. Roy. Soc. A*, **211**, 158–68 (*Feb.* 21, 1952).

A brief account of the organization, experimental facilities and the research work which is being carried out at A.E.R.E. Harwell. L. R. SHEPHERD

539.172

5300. Note on the angular distribution of radiation from fairly thin targets bombarded by high energy electrons. J. D. Lawson. *Phil. Mag.*, **43**, 306–8 (*March*, 1952).

It is shown that there are 2 essentially different ways of carrying out the analysis leading to slightly different results; this clarifies the position with regard to several recent calculations. W. J. SWIATECKI

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 5184–7

539.172 : 539.172.3

5301. Monte Carlo study of shower production. R. R. Wilson. *Phys. Rev.*, **86**, 261–9 (*May* 1, 1952).

Electron- and photon-initiated showers in Pb have been calculated in a simple Monte Carlo manner for energies from 20 to 500 MeV. The results, exhibited in a series of transition curves, show considerable differences from the results of conventional cascade theory in that the number of electrons at the maximum are fewer and the shower is more penetrating. The effects of multiple Coulomb scattering of the electrons have been included and depend markedly on the measurement considered. Thus, ionization currents are only slightly changed (the transition curves are foreshortened by about one-half radiation length) while the number of electrons counted behind Pb plates in a cloud chamber can be reduced by as much as 50% by effects of multiple scattering. This result is nearly independent of the incident energy. The final curves obtained are compared with the ionization measurement of Blocker, Kenney and Panofsky and the cloud-chamber measurements of A. M. Shapiro. The agreement is satisfactory. A simple quasi-analytic cascade theory is developed in which known low-energy solutions are used to obtain successively higher energy solutions. A.

539.172.11

5302. *Q*-values for $(\alpha\, p)$-reactions on fluorine and sodium. E. Hjalmar and H. Slätis. *Ark. Fys.*, **4**, 323–9 (*Paper* 14, 1952).

Continues the work of Slätis *et al.* [Abstr. 8958 (1951)]. A historical summary is given. New results, given also as curves, are for F^{19}: −1·27, 0·23, 1·0 and 1·57 MeV, and for Na^{23}: −1·17, −0·17, 1·15 and 1·55 MeV. F. R. HOLT

539.172.13

5303. On the capture of a neutron from a nucleus. V. I. Mamasakhlisov. Letter in *Zh. Eksper. Teor. Fiz.*, **21**, 948–9 (*No.* 8, 1951) *In Russian.*

Semi-classical considerations of a grazing collision of a proton on Be^9 show that the cross-section for the extraction of a neutron to form a deuteron is $\sim 0{\cdot}6 \times 10^{-29}$ cm², in agreement with the experiments of Allen (1937). W. J. SWIATECKI

539.172.13

5304. Proton bombardment of lithium. J. K. Bair, H. B. Willard, C. W. Snyder, T. M. Hahn, J. D. Kington and F. P. Green. Letter in *Phys. Rev.*, **85**, 946 (*March* 1, 1952).

Monoenergetic protons of between 1·8 and 5·3 MeV were used on natural Li. Forward neutrons showed a new peak at 4·89 MeV with full width of 0·4 MeV at

half maximum. This corresponds to a Be^8 excited state of 21·5 MeV. Constant γ intensity was found. F. R. HOLT

539.172.13

5305. The mass difference Mg^{23}–Na^{23}. H. B. WILLARD, J. D. KINGTON AND J. K. BAIR. Letter in *Phys. Rev.* **86,** 259 (*April* 15, 1952).

The proton threshold energy for the $Na^{23}(p, n)Mg^{23}$ reaction was determined as 5·091 ± 0·010 MeV. J. J. WILKINS

539.172.13

5306. The yield of F^{18} from medium and heavy elements with 420-MeV protons. L. MARQUEZ. *Phys. Rev.*, **86,** 405–7 (*May* 1, 1952).

The yield of F^{18} from medium and heavy elements, when bombarded with 420-MeV protons, was determined. Chemical procedures and techniques are described and the cross-sections varying from $2{\cdot}2\times10^{-2}$ barn for F to $4{\cdot}4\times10^{-6}$ for Au are given. Comparisons are made of these results with those of other heavy fragments obtained under similar conditions. A.

539.172.13

5307. Some investigations of (p, α) reactions on thin separated O^{18} and N^{15} targets. Techniques and results. C. MILEIKOWSKY AND R. T. PAULI. *Ark Fys.*, **4,** 299–322 (*Paper* 13, 1952).

A historical introduction is given and the equipment used is described in detail. The isotopes were separated electromagnetically, on to silver target backing plates. Proportional counters were more satisfactory than scintillation counters as yield detectors. α-energies were found by range measurement. Results are given as curves and are discussed theoretically. An O^{18} resonance at 680 keV and a N^{15} at 340 keV were found. F. R. HOLT

539.172.13 , 539.172.4

5308. Stars initiated by high energy protons and neutrons. H. FISHMAN AND A. M. PERRY, JR. *Phys. Rev.*, **86,** 167–70 (*April* 15, 1952).

Stars initiated in nuclear emulsions by 240-MeV protons and 180-MeV neutrons were studied. Size-frequency distributions of the stars and angular distributions of prongs in various energy intervals were obtained. Comparison with similar results obtained at different energies shows that the star size distribution is more sensitive to incident energy for protons than for neutrons. A.

539.172.13

5309. Radiations of Rh^{99}, Rh^{101}, Rh^{105} and Ru^{105}. C. L. SCOVILLE, S. C. FULTZ AND M. L. POOL. Letter in *Phys. Rev.*, **85,** 1046 (*March* 15, 1952).

Ru metal mounted on Zapon foil was bombarded with 6·3-MeV protons and 10-MeV deuterons. γ-ray, positron and negatron spectra were observed with a β-ray spectrometer. F. R. HOLT

539.172.13 : 539.152.1

5310. Energy levels of C^{11} and C^{12} from photographic plate observation of neutron spectra. V. R. JOHNSON. *Phys. Rev.*, **86,** 302–7 (*May* 1, 1952).

The energies of neutrons from $B^{10}(d, n)C^{11}$ and $B^{11}(d, n)C^{12}$ reactions have been measured by use of photographic emulsions and enriched B^{10} targets. Neutron groups corresponding to levels in C^{11} at 1·85, 4·23, 4·77, 6·40, 6·77, 7·39, 8·08, 8·39, 8·62 and possibly 8·97 and 9·13 MeV, have been observed. Most of these levels in C^{11} show good correspondence to those previously reported for the mirror nucleus B^{11}. This correspondence supports the assumed equality of n–n and p–p forces. Neutrons from normal B targets were observed, corresponding to levels in C^{12} at 4·4-, 9·6-, 10·8-, 11·1-, 11·74-, 12·76-, 15·09- and 16·07-MeV excitation. There were also some indication of additional levels at 13·21-, 13·36-, 14·16- and 15·52-MeV excitation. A.

539.172.13

5311. The reaction $Li^6(t, p)Li^8$. C. D. MOAK, W. M. GOOD AND W. E. KUNZ. Letter in *Phys. Rev.*, **85,** 928 (*March* 1, 1952).

350-keV tritons were used, forming Be^{9*}. This decayed to Li^8, which was identified by its β^--decay to B^{8*}, for the half-life was 0·89 sec, and β's over 10-MeV were found. F. R. HOLT

539.172.3

5312. The photodissociation of the deuteron by high energy gamma-rays. S. KIKUCHI. Letter in *Phys. Rev.*, **85,** 1062 (*March* 15, 1952).

Differential cross-sections at 45°, 90° and 135° angles and 130- to 270-MeV gamma-ray energies were measured, using a gas target and nuclear emulsion detectors. Forward asymmetry and an increasing cross-section above 150 MeV are deduced. J. J. WILKINS

539.172.3

5313. The photodisintegration of the deuteron at intermediate energies. I. C. A. BARNES, J. H. CARVER, G. H. STAFFORD AND D. H. WILKINSON. *Phys. Rev.*, **86,** 359–72 (*May* 1, 1952).

Measurements were made of the absolute cross-section for photodisintegration of the deuteron at 6 γ-ray energies in a range where the photomagnetic effect is small compared with the photoelectric. The methods of determining the γ-ray flux are described as are the h.p. D-filled ionization chamber and proportional counter used to determine the disintegration rate. A.

539.172.3

5314. The photodisintegration of the deuteron at intermediate energies. II. D. H. WILKINSON. *Phys. Rev.*, **86,** 373–6 (*May* 1, 1952).

The measurements reported in Pt I are analysed. The cross-sections for the electric dipole disintegration from the ^3S-state are obtained by subtracting small computed magnetic dipole and ^3D-state contributions. The electric dipole cross-sections are analysed from the point of view of both square well and Yukawa-type interactions and the effective ranges are found. A.

539.172.3

5315. Photodisintegration of the deuteron. V. E. KROHN, JR, AND E. F. SHRADER. *Phys. Rev.*, **86,** 391–5 (*May* 1, 1952).

The angular distribution of the protons from the $d(\gamma, n)p$ reaction has been investigated for 5–13-MeV γ-rays by means of the D_2O loaded emulsion technique with the Case betatron serving as γ-ray source.

e results have been compared to a differential cross-tion of the form $d\sigma = \{a + (b + c\cos\theta)\sin^2\theta\}d\Omega$ the centre-of-mass system and the isotropy coefficient found consistent with the mean values: $a/b = 04 \pm 0{\cdot}03$ from 5 to 11 MeV and $0{\cdot}24 \pm 0{\cdot}07$ om 11 to 13 MeV. The forward asymmetry coefficient was determined for energies above 8 MeV and und to be $c/b = 0{\cdot}24 \pm 0{\cdot}09$. These results are agreement with the theoretical calculations of arshall and Guth except for the isotropy coefficient served above 11 MeV where the theory predicts $b \sim 0{\cdot}01$. A.

539.172.3

316. Photodisintegration by meson reabsorption. R. Wilson. Letter in *Phys. Rev.*, **86**, 125 (*April* 1, 952).

High-energy photodisintegration cross-sections and ngular distributions are accounted for by assuming eson emission followed by reabsorption by a system onsisting of the parent nucleon and a neighbouring ucleon. J. J. WILKINS

539.172.3

317. The photodissociation of the helium nucleus by igh energy gamma-rays. S. Kikuchi. Letter in *hys. Rev.*, **86**, 126 (*April* 1, 1952).

Compared with previous results for deuterium Abstr. 4605 (1952)], more low energy protons and imilar distributions of high-energy protons were etected. The latter are attributed mainly to absorption of the photon by a two-nucleon system. J. J. WILKINS

539.172.3

318. New technique for the determination of photo-uclear cross sections. L. L. Newkirk. Letter in *Phys. Rev.*, **86**, 249 (*April* 15, 1952).

A mechanical device slides test and monitor samples lternately into a synchrotron beam, the electron nergy being switched in synchronism between two alues. Results for the $Cu^{63}(\gamma, n)Cu^{62}$ and $C^{12}(\gamma, n)C^{11}$ eactions are given. J. J. WILKINS

539.172.3

319. Interpretation of experiments on the photo-uclear effect in heavy elements. L. Eyges. *Phys. Rev.*, **86**, 325–32 (*May* 1, 1952).

An analysis of the experiments to date on photo-uclear reactions in heavy nuclei leads to the following esults. There is a correlation between the energy at which the (γ, n) cross-section is a maximum and the $(\gamma, 2n)$ threshold. The shape of the total photon absorption cross-sections in Sb and Ta can be estimated up to 22 MeV, and there is an indication that the cross-section drops off strongly above that energy. Using the estimate of the shape of the total cross-section in Ta, one can calculate the neutron yield to be expected in experiments with 330-MeV bremsstrahlung. The calculated value is only about 60% of the experimental value. Evidence is presented that the discrepancy is due to neutrons produced by high-energy photons, presumably due to mesonic effects. The integrated cross-sections for Zn^{64}, Sb and Ta^{181} can be evaluated and by comparison with the Levinger–Bethe formula lead to values of $0{\cdot}56$, $>0{\cdot}44$ and $0{\cdot}50$, respectively, for the fraction of exchange force in the neutron-proton interaction, assuming that all of the photoeffect is due to electric dipole transition. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

5320. The Cherenkov effect for the meson field. D. I. Blokhintsev and V. L. Indenbom. *Zh. Eksper. Teor. Fiz.*, **20**, 1123–9 (*No.* 12, 1950) *In Russian.*

During passage of a fast nucleon no mesons are produced from the interior of the nucleus. Passage through the boundary gives rise to a meson emission; this radiation is connected with polarization of the nuclear matter which is usually neglected. It is called "non-bremsstrahlung," as it is a meson radiation by nucleons of the substance, set vibrating through the passage of the primary nucleon. J. JACOBS

539.18

5321. Non-decelerating production of mesons [nucleon Cherenkov radiation]. V. L. Indenbom. *Zh. Eksper. Teor. Fiz.*, **21**, 737–47 (*No.* 6, 1951) *In Russian.*

The cross-sections for the production of mesons (scalar, vector and ps. scalar) associated with the penetration of a fast nucleon into nuclear matter are estimated. For the case of penetration into a nucleus they are proportional to $A^{\frac{4}{3}}$ and are of the same order of magnitude as the volume term, proportional to A and treated by Blokhintsev and Indenbom (preceding abstract). W. J. SWIATECKI

539.18

5322. The decay of neutral mesons. R. Oehme. *Z. Naturforsch.*, **7a**, 55–60 (*Jan.*, 1952) *In German.*

From general invariance properties it is deduced that the probability for the decay of a neutral meson with spin 0 into an electron and positron vanishes in second order of the fine structure constant and all orders of the meson-nucleon coupling, independently of the meson mass. The same is true for ps. scalar mesons, but for vector mesons the matrix element of lowest order is non-zero. The most probable mode for spin 0 π° mesons is decay into γ-quanta. Vector π° decay mainly into e^-, e^+ pairs. With ps. vector mesons it is not possible to ascertain uniquely whether decay into a pair and a γ is more probable than into 3 γ's. The experimental evidence for neutral mesons decaying into pairs or 3 γ's is discussed. It appears that the creation of such particles through the capture of π^- in H_2 is very improbable and it is indicated how their production in nuclear collisions could be demonstrated. W. J. SWIATECKI

539.18

5323. The ionization loss of energy of relativistic mu-mesons in argon. J. E. Kupperian, Jr, and E. D. Palmatier. Letter in *Phys. Rev.*, **85**, 1043 (*March* 15, 1952).

The variation with energy of the ionization loss of cosmic-ray mu-mesons in proportional counters filled to 1·6 atm. with 97% A and 3% CO_2 showed the

expected relativistic rise, in agreement with the theories of Bethe, Bloch and Williams. W. J. SWIATECKI

539.18

5324. Electromagnetic interference effects in charged meson-proton scattering. M. F. KAPLON. Letter in *Phys. Rev.*, **85**, 1059 (*March* 15, 1952).

The PS and PV interactions in PS meson theory may be distinguished by comparison of scattering of π^+ and π^- mesons by protons, since the sign of the nuclear scattering amplitude is obtainable from its interference with the Coulomb scattering. The magnitude of this effect is calculated in weak coupling theory, and curves showing its energy dependence are given. R. H. DALITZ

539.18

5325. Energy spectrum of μ-mesons arising from the disintegration of κ-mesons. L. MICHEL AND R. STORA. *C.R. Acad. Sci.* [*Paris*] **234**, 1257–9 (*March* 17, 1952) *In French.*

This is calculated assuming the scheme $\kappa \rightarrow \mu + 2\nu$ and a direct interaction; if this interaction is chosen "the same" as that which gives $\mu \rightarrow e + 2\nu$, one finds a lifetime τ_κ of 10^{-10}–10^{-9} sec. W. J. SWIATECKI

539.18

5326. Angular distribution of π^+ production in *n–p* collisions. H. A. BETHE AND N. AUSTERN. Letter in *Phys. Rev.*, **86**, 121–2 (*April* 1, 1952).

The expected distribution is discussed on the basis of the theories of Chew *et al.* [Abstr. 516 (1952)] and Watson and Brueckner [Abstr. 6748 (1951)], and is found to provide a sensitive test for the type of coupling between meson field and nucleus.

W. J. SWIATECKI

539.18

5327. The production of positive mesons by photons. J. STEINBERGER AND A. S. BISHOP. *Phys. Rev.*, **86**, 171–9 (*April* 15, 1952).

Experimental results are presented on the production of positive mesons in H and C, as a function of meson angle and energy. The principal results are as follows: The angular distribution in the case of H is rather flat in the region 45°–135° in the laboratory system, slightly peaked near 90°. This demonstrates that the pion is not a scalar. The excitation function at 90° rises approximately linearly to a plateau which starts at photon energies of about 260 MeV. This rise is slower than expected on the basis of a phase space argument. The total cross-section for 255-MeV photons in H is $1{\cdot}9 \pm 0{\cdot}3 \times 10^{-28}$ cm². The cross-sections in C are lower, per proton, by a factor of approximately 3. With respect to H, the meson energy distribution is shifted to lower energies and the angular distribution is shifted to the backward angles. A.

539.18

5328. Further results on the production of neutral mesons by photons. W. K. H. PANOFSKY, J. N. STEINBERGER AND J. STELLER. *Phys. Rev.*, **86**, 180–9 (*April* 15, 1952).

Further measurements were made on the photoproduction of neutral mesons using the γ–γ coincidence technique. New data were obtained on the γ–γ correlation curves in Be. The angular distribution of the photomesons in Be has been determined and found to be strongly peaked forward. The dependence on the atomic number A of production has been found to obey an $A^{\frac{2}{3}}$ law. Some data obtained for production in H show that the π^0 and π^+ production cross-sections are comparable and that the π^0 excitation curve starts more slowly from threshold than does the π^+ photo-excitation curve. A.

539.18

5329. High energy collisions with the production of meson showers. S. BISWAS AND V. D. HOPPER. *Phys. Rev.*, **86**, 209–11 (*April* 15, 1952).

Eighteen events of meson showers produced in high-energy collisions were analysed to study the mechanism of the production of mesons. The angles ψ of the mesons were measured relative to the primary direction or relative to the shower axis for neutron induced showers. The mean value of $\cos\psi$, $\langle\cos\psi\rangle_{Av}$, was plotted against the number N of the mesons produced. It is found that the observed points can be divided into 3 regions corresponding to single, double and triple collisions inside the nucleus. The points representing single collisions lie considerably below the theoretical curve of Heisenberg for completely inelastic collisions and it is concluded that in these collisions only a fraction $(1/K)$ of the incident energy goes to the meson production. For these events the values of K and primary energy E_p were estimated by applying Heisenberg's theory to partially inelastic collisions. For double and triple collision events the number of mesons produced in successive collisions inside the nucleus was estimated from the angular dispersions of the single collision events. A.

539.18

5330. V⁰ particles and isotopic spin. D. C. PEASLEE. Letter in *Phys. Rev.*, **86**, 127–8 (*April* 1, 1952).

The failure to observe V^{++} suggests that the V-particle wave functions have some components with isotopic spin $t < \frac{3}{2}$. This would mean that independent principles must be found to explain both the π- and γ-stability without help from isotopic spin considerations. W. J. SWIATECKI

539.18 : 537.564

Experimental study of the ionization produced in gases by mesons of great energy. *See Abstr.* 5179

539.18 : 537.591.1

5331. Decay of V⁰-particles. M. DEUTSCHMANN. Note in *Z. Naturforsch.*, **7a**, 142–3 (*Jan.*, 1952) *In German.*

Seven V⁰-decay events obtained near sea level in a large (75 cm × 75 cm × 30 cm) cloud chamber are reported. In no case was electron-shower development, which might arise were one product of decay a π^0-meson, observed, and the results are considered to support the existence of two species of V⁰-particle of different mass. J. G. WILSON

539.181

5332. Stopping power of heavier substances. J. LINDHARD AND M. SCHARFF. Letter in *Phys. Rev.*, **85**, 1058 (*March* 15, 1952).

When the dynamics of atoms is described on classical lines on the basis of the Thomas–Fermi model the specific energy loss of a fast atomic particle

of velocity v and low charge may, from dimensional arguments, be written as a function of Z/v^2. This is borne out by experiments. W. J. SWIATECKI

539.181.2

5333. On D. L. Simonenko's paper "Method of obtaining molecular beams." M. M. BREDOV, V. M. DUKELSKIĬ AND V. M. TUCHKEVICH. *Zh. Eksper. Teor. Fiz.*, **20**, 1143 (*No.* 12, 1950) *In Russian.*

See Abstr. 7514 (1950). Simonenko's assumption that the complete disappearance of the current towards the ion receiver is due to the neutralization of ions by electrons, is criticized. The effective cross-section for the ion-electron recombination, as calculated from Simonenko's data, is of the order of 10^{-8} cm^2, while the generally accepted value is 10^{-18}–10^{-20} cm^2. F. LACHMAN

539.185

5334. On the spectrum of evaporation neutrons. G. LÜDERS. *Z. Naturforsch.*, **7a**, 39–43 (*Jan.*, 1952) *In German.*

Using a simple well model of the nucleus the capture cross-section for neutrons (which enters into the calculation of the inverse evaporation process) is calculated. For energies $>0{\cdot}5$ MeV the cross-section is roughly constant, but for smaller energies significant deviations are introduced. W. J. SWIATECKI

539.185

5335. On the scattering of slow neutrons by polycrystals. P. O. FRÖMAN. *Ark. Fys.*, **5**, 53–60 (*Paper* 3, 1952).

Mathematical. Following on a previous paper [Abstr. 3896 (1952)] the author considers the scattering cross-section of a single crystal, neglecting magnetic interaction, spin-dependent interaction and isotope disorder. Particular attention is paid to elastic and inelastic scattering, and to the effect of temperature, Weinstock's earlier work being simplified and generalized. J. THEWLIS

539.185

5336. The tetraneutron. K.-H. SUN, F. A. PECJAK AND A. J. ALLEN. Letter in *Phys. Rev.*, **85**, 942 (*March* 1, 1952).

No evidence was found for the reactions, $Rh^{103}(n, n^4)Rh^{100}$, $Bi^{209}(n, n^4)Bi^{206}$, for 18 MeV neutrons. This indicates that either the tetraneutron does not exist, or if it exists, the binding energy is less than 3 MeV, or the cross-sections less than a few microbarns. J. HUGHES

539.185

5337. Scattering of 200-MeV nucleons by α-particles. J. HEIDMANN. *C.R. Acad. Sci.* [*Paris*] **234**, 1446–8 (*March* 31, 1952) *In French.*

Extension of previous work [Abstr. 6080 (1950)] to nucleons of higher incident energy (200 MeV).

A. O. STANESBY

539.185

5338. The inelastic scattering of very slow neutrons by iron. R. LATHAM AND J. M. CASSELS. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 241–5 (*April*, 1952).

The increase with temperature of the total cross-section of iron for very slow neutrons has been measured with the help of a cyclotron and a neutron velocity selector. Part at least of this increase is caused by the inelastic scattering associated with lattice vibrations, but the observed rise in cross-section is much greater than is predicted by the theory of this effect. It is suggested that a ferromagnetic scattering process may be responsible for the discrepancy. A.

539.185

5339. The inelastic scattering of fast neutrons from iron. P. H. STELSON AND W. M. PRESTON. Letter in *Phys. Rev.*, **86**, 132–3 (*April* 1, 1952).

1·9 MeV neutrons scattered through 90° by a 2-cm iron cylinder were detected by the tracks of recoil protons in emulsions. Their spectrum shows a peak corresponding to the excitation of a level at 850 ± 50 keV in Fe^{56}. The resolution of the method is sufficient to separate many low-lying levels.

W. J. SWIATECKI

539.185

5340. Angular distribution of neutrons scattered by helium. R. K. ADAIR. *Phys. Rev.*, **86**, 155–62 (*April* 15, 1952).

A proportional counter filled with He was irradiated with monoenergetic fast neutrons produced by bombarding thin Li- and T-filled Zr targets with protons from the electrostatic generator. Angular distributions of the neutrons scattered by He were determined by measuring the distribution in energy of the pulses from recoiling alpha-particles with a differential discriminator. Measurements were made for 11 different neutron energies from 400 keV to 2730 keV. The angular distributions were consistent with a description of the neutron-He interaction in terms of an inverted $P_{\frac{3}{2}}$–$P_{\frac{1}{2}}$ doublet in He^5, split by about 5 MeV. A.

539.185

5341. The scattering of neutrons by systems of heavy nuclei. G. PLACZEK. *Phys. Rev.*, **86**, 377–88 (*May* 1, 1952).

It is shown that the scattering of neutrons by a system of heavy nuclei may, for neutron energies that are large compared with the level separation of the system, be described in terms of averages of simple two-particle operators over the initial state. Expressions are derived for the total and differential cross-sections and for the first few moments of the energy transfer. The expression for the cross-section can be explicitly evaluated even for complicated scattering systems and leads to an accurate representation of the energy dependence of the nuclear scattering. The results are applied to the problem of the detection of small electronic contributions to the cross-section. A.

539.185

5342. Neutron-proton scattering with spin-orbit coupling. I. General expressions. J. M. BLATT AND L. C. BIEDENHARN. *Phys. Rev.*, **86**, 399–404 (*May* 1, 1952).

Neutron-proton scattering in the triplet spin state is discussed under the following assumptions about the nuclear forces: (1) the forces are conservative, (2) they allow time-reversal, i.e. the reciprocity law is valid, (3) the spin vectors of the neutron and proton enter in a symmetrical way, so that the total

spin of the system is preserved during the collision, and (4) the forces have a finite range. It is not assumed that the forces can be derived from a potential function (i.e. that they are velocity-independent). General expressions are given for the scattering matrix and for the differential cross-section. The matrix elements of the scattering matrix are expressed in terms of the minimum numbers of real, independent parameters. The energy dependence of these parameters near zero energy can be predicted uniquely on the basis of assumptions (1) to (4) above. A.

STRUCTURE OF SOLIDS 539.2

539.213

5343. Amorphous carbon. T. D. Smith. *J. Chem. Soc.*, (1952) 923–7 (*March*).

Carbons, prepared by carbonization of organic compounds, have been examined by X-ray diffraction and gas adsorption. The presence of oxygen in the organic molecule profoundly affects the crystallographic character of the resultant chars. Surface areas of these chars vary appreciably: very large areas may be due to the presence of a highly porous three-dimensional cross-linked structure; small areas occur when the material decomposes in the fused state. A.

539.215.2 : 548.735.7

5344. A dynamical model of a crystal structure. IV. Grain boundaries. W. M. Lomer and J. F. Nye. *Proc. Roy. Soc. A*, **212**, 576–84 (*May* 22, 1952).

For Pt III, see Abstr. 2799 (1951). Four photographs of bubble rafts are used as a basis for discussion of the structure of grain boundaries in pure metals. In these photographs one can follow the gradual transition from a small-angle boundary made up of clearly separate dislocations to a large-angle boundary where the dislocation structure is hardly recognizable. As the angle is increased, a continuous shortening of the dislocations, accompanied by the widening of a crack on the tensile side, is seen, and the process culminates in a structure which is perhaps best described in terms of local fit and misfit. The fact is also illustrated that the dislocation content of the boundary depends on the angle of the boundary, as well as on the disorientation of the crystals that it separates. If a boundary turns it must therefore gain or lose dislocations. The bearing of this on the measurement of grain-boundary energies is discussed. Other points considered concern the range of validity of calculations of the energy of dislocation walls and slip and diffusion along grain boundaries.

539.23

5345. Measurements on the formation of thin tin films. A. van Itterbeek, L. de Greve and F. Heremans. *Appl. Sci. Res. B*, **2**, 352–60 (*No.* 5, 1952).

The films were sputtered in helium or neon gas, and the specific resistance and the temperature coefficient measured as a function of thickness. The oxidation phenomenon was studied by means of the change in resistance as a function of time. The structure of the films was analysed by means of th electron microscope. It was found that the layers an composed of small grains, the dimensions of whic were determined.

539.26 : 539.4.01

5346. A study of cold-worked aluminium by an X-ra micro-beam technique. I. Measurement of partici volume and misorientations. P. B. Hirsch and J. M Kellar. *Acta Cryst.*, **5**, 162–7 (*March*, 1952).

When Al is cold-rolled, the original grains break up into smaller particles. X-ray micro-beam back reflection photographs permit the determination o the mean particle size and misorientation, and of thei variation with degree of deformation, time afte rolling and purity of specimen. It is found that fo spectroscopically pure Al a limiting particle size o ~2 μ is reached after ~10% reduction in thickness and that the total range of misorientations of th particles in the original grain is several degrees, whil the mean angle between neighbouring particles i estimated to be ~2°. The particle size decrease slightly with time after rolling; for impure Al, bot the limiting particle size and the mean angle betwee adjacent particles are smaller. A

539.26 : 539.4.01

5347. A study of cold-worked aluminium by an X-ray micro-beam technique. II. Measurement o shapes of spots. P. B. Hirsch. *Acta Cryst.*, 5 168–72 (*March*, 1952).

A method is described for obtaining from the shapes of the spots on spotty-ring photograph approximate values of the physical broadenings o the reflections. The method is used to determin the broadenings of the reflections from particles o specimens of cold-rolled Al examined by the micro beam technique. It is found that the physica broadenings decrease with time after rolling. The general application of the method to spotty-ring an Laue photographs from stationary specimens i discussed. A

539.26 : 539.4.01

5348. A study of cold-worked aluminium by an X-ray micro-beam technique. III. The structure o cold-worked aluminium. P. B. Hirsch. *Acta Cryst.*, 5 172–5 (*March*, 1952).

The results reported in the two preceding abstract are discussed in the light of present theories of plastic deformation of metals. It is estimated that there are $\sim 10^{10}$ dislocations/cm^2 in the boundaries between particles in cold-worked Al. The physical broadenings of the X-ray reflections from the particles are discussed, and it is concluded that the particles are distorted. Some deductions are made about the possible types of distortion in the particles. The formation of particles is considered to be due to polygonization. The changes which occur during recovery and those induced by impurities are interpreted on this basis. A

539.27

5349. A method of preparing [NaCl] crystals that undergo changes under electron bombardment in an electron microscope. P. de Souza Santos and H. Brandao Lopes. Letter in *Nature* [*Lond.*] **169** 498–9 (*March* 22, 1952).

539.27

5350. Application of the ultrathin freezing-sectioning technique to the study of cell structures with the electron microscope. H. FERNÁNDEZ-MORÁN. *Ark. Fys.*, **4**, 471–83 (*Paper* 31, 1952).

Gives practical details for cutting serial sections of 0·2–0·05 μ thickness from frozen tissue with a standard microtome. Results obtained on a wide variety of specimens are exhibited. 26 references.

R. S. PEASE

539.27 : 539.23

5351. A study of oxide films formed on copper–aluminium alloys by electron diffraction. H. TAZAKI AND S. KUWABARA. *J. Sci. Hiroshima Univ. A*, **15**, 133–7 (*July*, 1951).

Previous work on copper–magnesium alloys [Abstr. 9742 (1951)] has been extended to include copper–aluminium alloys, containing up to 10% Al. The oxide films formed by heating for various times at different temperatures and pressures have been examined by electron diffraction. M. R. HOPKINS

ELASTICITY STRENGTH . RHEOLOGY 539.3/.8

539.32

5352. A new method of measuring the modulus of elasticity—application to cement mortar and concrete. A. MARGARIT. *Rev. Cienc. Apl.*, **6**, 28–31 (*Jan.–Feb.*, 1952) *In Spanish.*

The apparatus described in Abstr. 672 (1951) has now been further developed for measurements of the elasticity of cement mortar and concrete. The method depends on measuring the time taken to transfer energy from one pendulum to another via the specimen. In the present apparatus, the test-pieces are 140 cm long by 10 cm square or 10 cm by 8 cm. The specimen is attached to the machine in a vertical position, and, in order to calibrate the apparatus, tests have been made with beam specimens whose modulus of rupture has been determined in flexure. Various qualities of concrete were used and it was found that an approximately constant value was obtained by dividing the modulus of rupture by the time interval measured on the machine. It is now possible, therefore, to determine the modulus of other specimens by employing this constant and the measured time interval. A. C. WHIFFIN

539.32

5353. Measurement of dynamic properties of rubber. R. S. MARVIN. *Industr. Engng Chem.*, **44**, 696–702 (*April*, 1952).

The relation of the dynamic modulus to other rheological measurements on rubber-like materials is discussed. The experimental methods used in determining dynamic properties of rubber are classified into three groups depending on the relative values of the sample dimensions and the wavelength of sound in the sample. Examples of each group, with a short discussion of advantages and disadvantages of each, are given. An appendix includes derivations, based on an infinite, linear differential equation, for forced and free vibration, and relates some of the more commonly used methods of expressing the results of dynamic measurements. A.

539.32

5354. Temperature dependence of dynamic properties of elastomers; relaxation distributions. J. D. FERRY, E. R. FITZGERALD, L. D. GRANDINE, JR AND M. L. WILLIAMS. *Industr. Engng Chem.*, **44**, 703–6 (*April*, 1952).

By the use of reduced variables, the temperature dependence and frequency dependence of dynamic mechanical properties of rubber-like materials can be interrelated without any arbitrary assumptions about the functional form of either. The definitions of the reduced variables are based on some simple assumptions regarding the nature of relaxation processes. The real part of the reduced dynamic rigidity, plotted against the reduced frequency, gives a single composite curve for data over wide ranges of frequency and temperature; this is true also for the imaginary part of the rigidity or the dynamic viscosity. The real and imaginary parts of the rigidity, although independent measurements, are interrelated through the distribution function of relaxation times, and this relation provides a check on experimental results First and second approximation methods of calculating the distribution function from dynamic data are given. The use of the distribution function to predict various types of time-dependent mechanical behaviour is illustrated. A.

539.32

5355. Correlation of dynamic and static measurements on rubberlike materials. R. D. ANDREWS. *Industr. Engng Chem.*, **44**, 707–15 (*April*, 1952).

Dynamic and static measurements on rubber-like materials can be related in terms of a generalized Maxwell model which is assumed to represent the mechanical behaviour of the system, the individual characteristics of the system being expressed by the nature of the relaxation time distribution of the model. Such properties as dynamic modulus and dynamic viscosity measured in experiments involving sinusoidal vibrations, and static modulus measured in experiments of relaxation of stress at constant strain can be expressed by integrals involving the distribution of relaxation times. The distribution of relaxation times can therefore be calculated from experimental data of this sort by suitable mathematical methods. Because of the complexity of such calculations when carried out rigorously, the use of approximate methods is often desirable. A number of useful approximate relations can be derived by investigation of the mathematical structure of the integrals relating the distribution of relaxation times to the observed properties and by examination of the behaviour of certain particular relaxation time distributions. Attempts to correlate dynamic and static data on the basis of this general theory, by use of the approximate relations discussed, have been reasonably successful. A.

539.32 : 537.228.1

Elastic constants of $Li_2SO_4 . H_2O$. *See Abstr.* 5105

539.32 : 548.0

5356. The elastic behaviour of a crystalline aggregate. R. HILL. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 349–54 (*May*, 1952).

The connection between the elastic behaviour of an aggregate and a single crystal is considered, with special reference to the theories of Voigt, Reuss and Huber and Schmid. The elastic limit under various stress systems is also considered; in particular, it is shown that the tensile elastic limit of a face-centred aggregate cannot exceed two-thirds of the stress at which pronounced plastic distortion occurs. A.

539.37

5357. Elastic and plastic properties of very small metal specimens. C. HERRING AND J. K. GALT. Letter in *Phys. Rev.*, **85**, 1060 (*March* 15, 1952).

Experiments on very fine Sn "whiskers" ($\sim 10^{-4}$ cm diameter) show these to have an elastic and plastic behaviour not far different from that to be expected for a really perfect crystal. A permanent deformation, when the whisker becomes quite sharply bent at one point, is achieved only with strains $\sim$ 2–3%.

A. D. LE CLAIRE

539.374

5358. X-ray and electron microscope photographs of plastically deformed monocrystals of aluminium. E. V. KOLONTSOVA. *Zh. Eksper. Teor. Fiz.*, **21**, 821–5 (*No.* 7, 1951) *In Russian.*

On the basis of X-ray and electron-microscope photographs [reproduced] it is concluded that the process of plastic deformation is accompanied by recrystallization of regions of the crystal which adjoin planes of slipping. A. L. MACKAY

539.389.3

5359. Problem of relaxation of mechanical stresses. J. KUBÁT. Note in *Naturwissenschaften*, **39**, 107 (*No.* 5, 1952) *In German.*

It is assumed that the equation $[d(df/dt)]/df = -k$ (f — stress, t — time, k — constant), showing the stress decrement, is an approximation only, and a form is suggested similar to Eyring's equation. The new equation can be transformed into $[d(df/dt)]/df = -ab + adf/dt$ and finally into $df/dt = C/(De^{abt} + 1)$. By studying stress relaxation in paper, the author observed that a decreased as the plastic deformation increased. F. LACHMAN

539.4.011.25 : 666

5360. The fracture velocity of a glass at liquid hydrogen temperatures. H. M. DIMMICK. *J. Soc. Glass Techn.*, **35**, T318–T319 (*Dec.*, 1951).

The limiting velocity of fracture for a soda–lime–silica glass was measured at the temperature of liquid hydrogen (20°K) and found to be 1542 m/sec. This value lies on a continuation of the straight line of fracture velocity v. temperature previously reported over the range of 77°–475°K. The temperature coefficient of fracture velocity is therefore approximately $-0{\cdot}15$ m/sec/°K over the entire range studied with no discontinuities within the experimental error. A.

539.4.016.2 : 537.312.9

5361. Recovery of the resistivity of metals after cold-working. J. A. MANINTVELD. Letter in *Nature* [*Lond.*] **169**, 623 (*April* 12, 1952).

Continuing the work of Abstr. 1251 (1952), new data are presented for Cu, Ag and Au. Activation energies are calculated assuming that the recovery of $\Delta\rho/\rho$ is due to the movement of vacant lattice sites.

J. E. CAFFYN

539.42 : 537.228.1

5362. Mechanical strength of piezoelectric crystals. R. BECHMANN AND P. L. PARSONS. *Brit. J. Appl. Phys.*, **13**, 147–50 (*May*, 1952).

A direct mechanical method and an electrical method have been used to determine the mechanical strength of the piezoelectric materials sodium chlorate, sodium bromate, ammonium dihydrogen phosphate, ethylene diamine tartrate and lithium sulphate monohydrate. New measurements have also been made on quartz as a check on the methods. A formula for the current due to the piezoelectric polarization is given which covers the longitudinal flexural, contour and thickness modes of vibration considered. The maximum safe current for piezoelectric resonators has been calculated for specific cuts of the various materials. A.

539.537 : 537.228.1

5363. A study of some impacts between metal bodies by a piezo-electric method. A. W. CROOK. *Proc. Roy. Soc. A*, **212**, 377–90 (*May* 7, 1952).

Continuous measurements of the force throughout impacts between metal cylinders and between a hard sphere and metal flats are described. The force has been measured piezoelectrically. Within their appropriate ranges the theories of elastic impacts due to St. Venant and Hertz have been confirmed. For impacts so hard that the elastic regime preceding plastic deformation may be neglected, it is shown that the experimental results agree closely with force-time curves calculated, assuming that deformation is opposed by a constant pressure. This dynamic flow pressure is greater than the similarly defined pressure experienced in static tests and the new information given by the piezoelectric method shows that this difference cannot be accounted for satisfactorily in terms of forces of a viscous type. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.11 : 539.132

5364. Thermochemical dissociation energies of gaseous calcium, strontium and barium oxides. G. DRUMMOND AND R. F. BARROW. *Trans Faraday Soc.*, **47**, 1275–7 (*Dec.*, 1951).

Thermochemical values are calculated for the dissociation energies of gaseous CaO, SrO and BaO. The results are in good agreement with the equilibrium measurements of Huldt and Lagerqvist [*Ark. Fys.*, **2**

Paper No. 31 (1950)] but differ from the spectroscopic values. A.

541.115

5365. An investigation of the pyrolyses of cumene, *t*-butyl-benzene and *p*-cymene, and the relevant bond dissociation energies. C. H. LEIGH AND M. SZWARC. *J. Chem. Phys.*, **20**, 844–6 (*May*, 1952).

The pyrolysis of cumene, *p*-cymene and *t*-butyl-benzene was investigated. From the experimental data the relevant bond dissociation energies and the heats of formation of the respective radicals were computed. A.

541.123.3

5366. Cryoscopic study of solutions of certain metallic oxides in the eutectic cryolite-sodium fluoride. G. PETIT. *C.R. Acad. Sci.* [*Paris*] **234**, 1281–3 (*March* 17, 1952) *In French.*

Cryoscopic curves are given for La_2O_3, ThO_2, Al_2O_3, CeO_2, CaO, BeO (GlO) and B_2O_3 in the eutectic AlF_3 . 3NaF — NaF at 885° and 1008°C. The curve for La_2O_3 is discussed; this becomes level at 3 particles which are shown to be $2LaO^+$ and O^{--}, the ion LaO_2^- not apparently existing under these conditions. The following equilibria are derived for the various oxides: $M_2O_3 \rightleftharpoons MO_2^- + MO^+$, $MO_2^- \rightleftharpoons MO^+ + O^{--}$ and $MO^+ \rightleftharpoons M^{+++} + O^{--}$; these are displaced by temperature, dilution and according to the electropositivity of the relevant metal. H. H. HODGSON

541.123.5

5367. The exchange of water between $Co(NH_3)_5H_2O^{+++}$ and solvent. A. C. RUTENBERG AND H. TAUBE. *J. Chem. Phys.*, **20**, 825–6 (*May*, 1952).

The rate of exchange of water between $Co(NH_3)_5H_2O^{+++}$ and solvent has been measured by a method involving isotopic assay of the bound water. The half-time for the exchange is independent of salt concentration and of acidity over a range of these variables and is 24·5 hr at 27°. The half-time is increased by $SO_4^{=}$, indicating that complex ion formation competes with the exchange process and thus supporting an S_N1 mechanism as a reaction path. The equilibrium quotient $[Co(NH_3)_5H_2O^{18+++}](H_2O)/(Co(NH_3)_5H_2O^{+++})\times(H_2O^{18})$ was measured as 1·019 ± 0·001. A.

541.124

5368. Kinetics of the decomposition of diethyl peroxide. R. E. REBBERT AND K. J. LAIDLER. *J. Chem. Phys.*, **20**, 574–7 (*April*, 1952).

The kinetics of the gas-phase decomposition of diethyl peroxide have been studied in a flow system, using excess of toluene. The main reaction products were found to be ethane and formaldehyde, and there were smaller amounts of methane and dibenzyl. The frequency factor of the reaction is $2\cdot1\times10^{13}$, and the activation energy is 31·7 kcal per mole. The mechanism of the reaction is discussed and it is shown that the measured rate must refer to the initial dissociation $C_2H_5OOC_2H_5 \rightarrow 2C_2H_5O$. With a new value of 47·8 kcal for the heat of formation of gaseous diethyl peroxide, the heat of formation of the C_2H_5O radical is calculated to be 8·1 kcal, which agrees satisfactorily with estimates from other kinetic data. Thermochemical values for other reactions involving this radical are calculated. A.

541.124

5369. The reaction of methyl radicals with some halogenated methanes. F. A. RAAL AND E. W. R. STEACIE. *J. Chem. Phys.*, **20**, 578–81 (*April*, 1952).

The reactions of methyl radicals formed by the photolysis of acetone with several halogenated methanes have been investigated between 110°c and 220°c. The activation energies of these reactions have been determined relative to the activation energy of the combination of methyl radicals and are found to be (in kcal): methyl fluoride 8·7, methylene fluoride 6·2, methyl chloride 9·4, methylene chloride 7·2, chloroform 5·8, methyl bromide 10·1, methylene bromide 8·7. The steric factors of the reactions are in the range 10^{-2}–10^{-4}. A.

541.124

5370. The reaction of methyl radicals with nitric oxide, and the rate of combination of methyl radicals. R. W. DURHAM AND E. W. R. STEACIE. *J. Chem. Phys.*, **20**, 582–5 (*April*, 1952).

Radioactive tellurium mirrors have been used to investigate the rate of reaction of methyl radicals with nitric oxide in a flow system. The collision efficiency of this reaction has been found to be $1\cdot5\times10^{-4}$, which is higher by a factor of 10 than the previous value obtained by Forsyth. This value when applied to results obtained by Miller and Steacie for the ratio of the two reactions $CH_3 + CH_3 \rightarrow C_2H_6$, $CH_3 + NO \rightarrow$ products, leads to a collision efficiency or steric factor, assuming the activation energy to be zero, of 0·01 for methyl combination. A comparison of this value with those obtained by other authors from photochemical studies suggest the value for the collision efficiency of methyl combination is between 0·5 and 0·05. A.

541.124

5371. On the decomposition of metallic azides. J. G. N. THOMAS AND F. C. TOMPKINS. *J. Chem. Phys.*, **20**, 662–5 (*April*, 1952).

The mechanisms suggested previously [Abstr. 2190 (1952)] for the formation and growth of nuclei in the decomposition of barium axide have been examined in detail. It is concluded that these cannot adequately account for the experimental results available on the thermal decomposition, and photo and ionic conductivity of this salt. A.

541.124

5372. On the cubic law of oxidation. J. T. WABER. *J. Chem. Phys.*, **20**, 734 (*April*, 1952).

Experimental and theoretical studies are reviewed to indicate that a cubic law of oxidation occurs at low temperatures. Data for tantalum and titanium have been presented to indicate that this growth law may apply to more metals than suspected in the past. A.

541.124

5373. Note on diffusion-controlled reactions. A. T. REID. *J. Chem. Phys.*, **20**, 915–16 (*May*, 1952).

Two diffusion problems arising in an application of the Smoluchowski collision theory of reaction rates in solutions are considered. The diffusion equations are nonhomogeneous due to the introduction of an expression for the rate of production of the reacting particles. Two cases are considered: (1) The rate is

constant, and (2) the rate is a linear function of the concentration. Solutions are obtained by the method of the Laplace transformation. A.

541.124 : 537.534.72

5374. Free radicals by mass spectrometry. I. The measurement of methyl radical concentrations. F. P. Lossing and A. W. Tickner. *J. Chem. Phys.*, **20**, 907–14 (*May*, 1952).

A method was developed for measuring the partial pressure of methyl radicals in thermally decomposing gases, using a modified mass spectrometer. The sensitivity of the instrument to methyl radicals was determined by decomposing known quantities of mercury dimethyl and di-*t*-butyl peroxide in a stream of carrier gas and measuring the amounts of the stable products and the net height of the mass 15 peak after correction for contributions from these stable products. Assuming a 100% carbon balance, the sensitivity of the instrument to methyl radicals was found to be $0{\cdot}47 \pm 0{\cdot}07$ of the sensitivity to methane under the conditions used. With the present instrument this means that an ion current of 3×10^{-14} ampere at mass 15 (a peak 1 cm in height) is given by a partial pressure of methyl of 0·02 micron Hg above the leak in the reactor. The rate constants for the decomposition of di-*t*-butyl peroxide have been measured with this instrument. Combining the values obtained with values from the literature yields a value of $E = 38$ kcal/mole and a frequency factor of 7×10^{15}. The rate of decomposition of mercury dimethyl was found to be dependent on the pressure of carrier gas in the reactor in the range from 5 to 20 mm. An estimate of the collision efficiency for the recombination of methyl radicals has been made using the partial pressures of methyl radicals measured by the method presented. At 850°c this value of the collision efficiency is $2\text{–}3\times10^{-2}$. A.

541.124 : 539.181

5375. Initiation of elementary chemical processes by molecular beams. H. Martin and H.-J. Meyer. Note in *Naturwissenschaften*, **39**, 85–6 (*No.* 4, 1952) *In German.*

541.126

5376. Gaseous detonations. III. Dissociation energies of nitrogen and carbon monoxide. G. B. Kistiakowsky, H. T. Knight and M. E. Malin. *J. Chem. Phys.*, **20**, 876–83 (*May*, 1952).

For Pt II, see Abstr. 6788 (1950). Detonation velocities were measured in mixtures of cyanogen and O at several pressures and in tubes of several diameters, with a reproducibility of the order of 0·1%. Thermodynamic calculations of detonation velocities were carried out for several assumed heats of dissociation of N and of CO and for several experimental conditions. Methods are described for the extrapolation of experimental velocities to the limit of an infinite plane wave in ideal gases. The comparison of these extrapolations with thermodynamic calculations gives best agreement for $D_{N_2} = 9{\cdot}76$ eV and $D_{CO} = 11{\cdot}11$ eV, the difference of experimental and calculated velocities averaging to 0·08%, with a standard deviation of 0·3%, which agrees with the predicted standard deviation. Several lower dissociation energies, which have been recommended on the basis of spectroscopic studies and of appearan potentials give such poor agreement with thes experimental data that they constitute very stron evidence in favour of the higher dissociation energie

541.12

5377. Gaseous detonations. IV. The acetylen oxygen mixtures. G. B. Kistiakowsky, H. T. Knigh and M. E. Malin. *J. Chem. Phys.*, **20**, 884–8 (*Ma* 1950).

Detonation velocities were accurately measured i acetylene-oxygen mixtures ranging in composition from 7 to 90% acetylene at 1 atm. total pressure. Th velocities rise very sharply with concentration t 50% acetylene, then drop equally sharply to about 70% and from then on rise slightly to 90%. The thermo dynamic calculations of velocities, in which n adjustable parameters were used, are in perfect agree ment with experimental data in the range of 25 to 50% acetylene. The velocity at 7%, near the detonabilit limit, is distinctly higher than the calculated value The calculated velocities from 50 to 90% acetylen lie on a smooth curve, showing no break near 70% acetylene as do the experimental data. They ar higher than the experimental velocities, except a 85 to 90% acetylene, where the two curves join again The disagreement in the intermediate composition range persists when the velocities are recalculate assuming a low heat of sublimation of C. A hypo thesis is advanced that no solid C is formed i detonation waves of mixtures containing up to 70% acetylene, because of delays in the nucleation process The velocities calculated with the assumptions o gaseous equilibria and of the formation of super saturated C vapour, are in acceptable agreement wit observations. A

541.126 : 542.94

5378. The oxidation of hexane in the cool-flam region. H. C. Bailey and R. G. W. Norrish. *Proc Roy. Soc. A*, **212**, 311–30 (*May* 7, 1952).

The chemical nature of the cool flame of hexane a 300°c, maintained stationary in a flow system a atmospheric pressure, has been investigated. The relative intensities of cool flames obtained from mixtures of differing composition have been measured using a photomultiplier cell, and correlated with analyses made of the complex mixture of reaction products. The stationary two-stage flames which may be obtained at either higher oxygen concentrations or higher pressures than the cool flame are also described, and investigated similarly. The results are examined in the light of a theory of combustion o the higher hydrocarbons via aldehydes and hydroxy radicals, which is an extension of a mechanism derive for the oxidation of methane. This receives considerable support, particularly from the identification of the complete homologous series of saturate aldehydes which can result from the hexane molecule Associated with these reactions are others due to th greater stability of peroxide radicals at 300°c than a the higher temperatures of methane oxidation. Thus the building up of a partial pressure of hydroperoxid sufficient to ignite in the presence of O may initiate the cool flame, and considerable amounts of cyclic

thers have been found which probably had a peroxidic precursor. A.

ELECTROCHEMISTRY 541.13

541.132 : 532.7

A criterion of electrolytic dissociation for fused salts. *See Abstr.* 4946

541.133 : 536.631

Specific heat of synthetic high polymers. I. A study of polyethylene including a statistical theory of crystallite length. *See Abstr.* 5086

541.135

5379. Effect of ionic micelles on the pH of solutions of sodium oleate. A. LEVIALDI. *C.R. Acad. Sci.* [*Paris*] **234,** 1287–9 (*March* 17, 1952) *In French.*

When foam is produced on an aqueous sodium oleate solution, the concentration of soap in the solution diminishes due to accumulation in the foam. However, the pH of the solution remains constant starting from a given initial concentration. This behaviour has been studied by using three different pH electrodes and the pH followed during the process of foam formation. It is concluded that the constant pH is due to the presence of ionic micelles. J. IBALL

541.135

5380. On strong electrolytes in solution. M. DUTTA. Note in *Naturwissenschaften,* **39,** 108 (*No.* 5, 1952).

It is shown that the formulae for distribution of ions in ionic atmosphere derived by Dutta and Bagchi [Abstr. 7559 (1950)] and by Eigen and Wicke [Abstr. 3967 (1952)] are actually identical. T. C. TOYE

541.135

5381. Remarks on the foregoing communication "On strong electrolytes in solution". E. WICKE AND M. EIGEN. Note in *Naturwissenschaften,* **39,** 108–9 (*No.* 5, 1952) *In German.*

The authors indicate reasons for their disagreement with the findings of Dutta (preceding abstract). T. C. TOYE

541.135.5

5382. Critical deposition potential of protactinium on various metals. J. DANON AND C. FERRADINI. *C.R. Acad. Sci.* [*Paris*] **234,** 1361–3 (*March* 24, 1952) *In French.*

The curves for the quantities of Pa^{233} (of period 27·4 days) deposited on various metallic cathodes with Pt anode from solutions in NaF at pH 5·9, plotted against the voltages, show critical deposition potentials as follows: Pt −1·45, Au −1·43, Ag −1·45, Cu −1·46 and Ni −1·14. There is no anodic deposition. H. H. HODGSON

541.135.5

5383. The mechanism of hydrogen evolution at nickel cathodes in aqueous solutions. J. O'M. BOCKRIS AND E. C. POTTER. *J. Chem. Phys.,* **20,** 614–28 (*April,* 1952).

Hydrogen overpotential at Ni cathodes has been measured under very pure conditions in aqueous solutions of HCl (0·001 N–1·0 N) and in aqueous NaOH (0·001 N–0·2 N). The measurements have been made in the current density range 10^{-8}–10^{-1} amp/apparent cm², and in the temperature range 0°–50°C. Observations were also made of the build-up and rate of decay of overpotential and of the capacity of the electrode/electrolyte interface. Direct measurements were made of the number of acts of the rate-determining step associated with one act of the over-all hydrogen evolution reaction (i.e., the stoichiometric number μ). The application of μ has been extended to hydrogen overpotentials greater than about −20 millivolts. The experimental data were treated statistically, and show that the most probable mechanism of hydrogen overpotential at Ni cathodes is that of a rate-determining discharge step followed by a recombination of H atoms. The discharge probably takes place from hydroxonium ions in acid solution. In alkaline solution the observed pH effect on overpotential is best explained by assuming that the discharge occurs from water molecules whose activity depends on the electrode field. Consideration of the role of chemisorption in the H electrode process indicates that a rate-determining discharge step can take place from a Ni surface substantially occupied with H atoms. A.

541.138

5384. Mechanism of corrosion by oxygen. R. AUDUBERT. *C.R. Acad. Sci.* [*Paris*] **234,** 1448–50 (*March* 31, 1952) *In French.*

The theory of overvoltage, when applied to the corrosion of metals in presence of oxygen, is shown to enable the determination of the mechanism of this phenomenon. The role of the oxygen in the dissolution of a metal in contact with an electrolyte is interpreted by thermodynamic considerations on the assumption that it reacts mainly in acid and neutral media. H. H. HODGSON

541.138

5385. Theory of overvoltage and the mechanism of attack of metals in solution in the absence of oxygen. R. AUDUBERT. *C.R. Acad. Sci.* [*Paris*] **234,** 1166–8 (*March* 10, 1952) *In French.*

It is shown that the theory of overvoltage, when applied to the dissolution of metals in oxygen-free media, enables a decision to be made as to whether the dissolution is direct or is the result of a secondary reaction. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

5386. The azomethane induced oxidation of propane. M. D. SCHEER AND H. A. TAYLOR. *J. Chem. Phys.,* **20,** 653–6 (*April,* 1952).

The effect of methyl radicals from the photolysis of azomethane on propane–oxygen mixtures in Pyrex vessels has been shown to include a slow oxidation in the temperature range 35° to 200°C and cool flames at 250°C. Azomethane decomposed thermally, induces cool flames in propane–oxygen mixtures at 255° and 270°C, temperatures below those at which

cool flames occur in the system propane–oxygen alone. A rapid photo-oxidation has been observed in a quartz vessel in the temperature range 230 to 250°C.

A.

541.14

5387. Photochemical studies with the gaseous flash discharge. I. Uranyl–oxalate actinometry at high intensities. M. I. CHRISTIE AND G. PORTER. *Proc. Roy. Soc. A*, **212**, 390–7 (*May* 7, 1952).

The possibility of applying uranyl–oxalate actinometry at the intensities produced by high-energy flash discharges is investigated. It is shown that the photochemical decomposition of oxalate produced by a high-energy flash is directly proportional to intensity over an intensity range of 1000. Since the rate of decomposition at the lowest flash intensity is comparable with that calculated for the highest intensity previously studied in uranyl–oxalate actinometry, it is concluded that the quantum yield of the uranyl–oxalate system is unchanged up to intensities 10^3 times greater than those previously investigated. The available output in the u.v. region is given for several experimental arrangements. A.

541.14

5388. Photochemical studies with the gaseous flash discharge. II. Ultra-violet characteristics of the flash discharge. M. I. CHRISTIE AND G. PORTER. *Proc. Roy. Soc. A*, **212**, 398–406 (*May* 7, 1952).

The u.v. characteristics of the continuous spectrum emitted by the gaseous flash discharge were examined by photometric and actinometric methods. The dependence of (*a*) energy distribution with wavelength and (*b*) total output in the photochemically useful region, on parameters such as energy of the discharge and nature and pressure of the gas filling is investigated. The energy emitted is independent of wavelength in the region 2600 to 4400 Å, whilst the energy distribution is independent of the nature of the gas filling, and also of the gas pressure and the energy input above certain critical limits. Above these limits the total output is given by the expression $J_u = kC(V^2 - V_0^2)$, where k is a constant depending on the over-all efficiency of the experimental arrangement. Owing to the extreme sensitivity of V_0 to traces of impurity in the gas filling, the output per flash of 2500 J for different fillings may vary by $\pm 10\%$. For any one filling the output is reproducible within the analytical accuracy. The results are discussed in relation to the mechanism of production of the continuum which is attributed to the recombination radiation of electrons. A.

541.15

5389. Radiation chemistry investigation of aqueous solutions using P^{32} and S^{35} as internal sources. T. J. HARDWICK. *Canad. J. Chem.*, **30**, 39–46 (*Jan.*, 1952).

The oxidation of ferrous ion and the reduction of ceric ion in 0·80 N sulphuric acid by electrons from dissolved P^{32} and S^{35} have been studied. The chemical yields (chemical change per unit energy absorbed) obtained agree well with those obtained using X- or γ-radiation. The yield is independent of electron energy above about 5 keV, The results show that chemical dosimetry methods may be used for the accurate determination of energy absorption fo electron energies as low as 45 keV or X-rays of 200 ke

541.1

5390. The Szilard–Chalmers process in solid phos phorus salts. A. H. W. ATEN, JR., H. VAN DE STRAATEN AND P. C. RIESEBOS. *Science*, **115**, 2 (*March* 7, 1952).

Solid P salts were exposed to slow neutrons. Th materials were dissolved in water containing carrie such as pyrophosphate, orthophosphate, phosphi and hypophosphite ions and the pyrophosphate wa precipitated with Zn or Cd ions. The experimen show that an appreciable fraction of the total activit is present as pyrophosphate ions, which is considere of some interest, as pyrophosphate formation doe not take place in dilute aqueous solutions.

T. A. CHALMER

541.1

5391. Excited molecule theory of radiation chemistr of liquids. M. BURTON, J. L. MAGEE AND A. H SAMUEL. Letter in *J. Chem. Phys.*, **20**, 760 (*Apri* 1952).

It is suggested that the chemical effects produced i water by ionizing radiation start from two classes c excited states, M^* and $M^\dagger$. M^* is primarily produce in the ionization column, has comparatively lo energy and is relatively persistent. $M^\dagger$ is produce by ion neutralization and decomposes (if at al relatively rapidly near the site of its production. Th bases for these conclusions are summarized.

C. B. ALLSOP

541.1

5392. Differences in reaction of macromolecul with X-rays and a nitrogen mustard. P. ALEXANDE AND M. FOX. *Nature* [*Lond.*] **169**, 572–4 (*April* 1952).

The effect of X-irradiation on the viscosity c polymethacrylic acid dissolved in water, and of nitrogen mustard on the viscosity of polyacrylic aci in water have been studied. It is established that decrease in viscosity is brought about either by chang in the shape of the macromolecule (by the nitroge mustard) or by degradation of the molecule (b X-rays). The results support the view that th chemical mechanism of the biological effect of X-ray and nitrogen mustard is different. H. MILLE

541.1

5393. Chemical kinetics of atomic bromine fro nuclear isomeric transition. W. H. HAMILL AND J. A YOUNG. *J. Chem. Phys.*, **20**, 888–93 (*May*, 1952).

Chemical evidence indicates that the nucle isomeric transition of Br^{80} is completely converte Although isomeric transition always produces C — H bond rupture in $CH_3Br(g)$ it often fails to ruptu $HBr(g)$. Other results are consistent with the inte pretation that daughter Br^{80} particles, following bon rupture, usually become free, thermal atoms. The kinetic behaviour with C_2H_4 — HBr mixtures corr sponds to the analogous $Br^{79}(n, \gamma)Br^{80}$ kinetics [Abst 7563 (1950)]. Using daughter Br^{80} it is shown th bromine addition at the C = C double bond do

not involve the Br_3 complex. The $HBr^{82} - Br_2$ exchange was found to be complete in two minutes. A.

541.15

5394. Mechanism of bond rupture in HBr^{80} following isomeric transition. J. L. MAGEE AND E. F. GURNEE. *J. Chem. Phys.*, **20**, 894–8 (*May*, 1952).

The work of Hamill and Young (preceding abstract) has demonstrated that only a fraction of $HBr^{80}(g)$ and $DBr^{80}(g)$ bonds are ruptured following isomeric transition in Br^{80}. It is known that this transition is completely converted and from the theoretical work of Cooper it is to be expected that all Br^{80} atoms should be separated from chemical combination. This paper presents a brief theoretical consideration of the rupture mechanism in HBr^{80} in an attempt to understand why the rupture does not always occur. Approximate potential energy curves for some of the various molecular ions HBr^{+z} which form during the Auger shower following conversion have been constructed. It is found that there is a very great possibility that these ions all have lowest electronic states which are stable with respect to the dissociation process $HBr^{+z} \rightarrow H^+ + Br^{+(z-1)}$, and the possibility for nonrupturing is thus qualitatively explained for the charging process, since the entire charging time is short compared with molecular collision time in the gas phase. A further necessary condition for nonrupturing (as measured by Hamill and Young) is that the ions can be discharged in collisions without rupture. This process is also considered briefly. The complete rupture of the $C - Br^{80}$ bond (in $CH_3Br^{80}(g)$) is also considered and explained qualitatively. In this case no stable molecular states exist for the ions and rupture occurs during the charging process. A.

541.15 : 539.166.93

5395. The oxidation of ferrous sulphate solutions by γ-rays—the absolute yield. T. J. HARDWICK. *Canad. J. Chem.*, **30**, 17–22 (*Jan.*, 1952).

The absolute value of the yield of ferric ion on the irradiation of ferrous sulphate in 0·80N sulphuric acid by γ-rays has been determined using the Bragg–Gray cavity principle. Sources of error in the measurements were reduced as much as possible. The yield obtained, $20{\cdot}8 \pm 0{\cdot}3$ ferric ions per 100 eV absorbed, agrees well with Miller's value of 20·7 molecules per 100 eV. A.

541.15 : 539.166.93

5396. The reduction of ceric sulphate solutions by ionizing radiation. T. J. HARDWICK. *Canad. J. Chem.*, **30**, 23–38 (*Jan.*, 1952).

The yield of cerous ions formed in the reduction of ceric ion in sulphuric acid solutions by X- and γ-radiation is independent of cerous and ceric ion concentration, the energy of the radiation, the rate of energy absorption over a wide range, the acid concentration, and the presence of oxygen. A small negative temperature coefficient has been observed. The over-all stoichiometric equation is $4Ce^{4+} + 2H_2O \rightarrow 4Ce^3 + 4H^+ + O_2$. Hydroxyl radicals postulated to be produced by the radiation form water and oxygen gas. The lower limit of concentration independence is below 2×10^{-6} moles per litre. A.

541.15 : 539.172.4

5397. Investigation of the forms of phosphorus in neutron-bombarded phosphates. Nature of the phosphorus-32. J. G. A. FISKELL, W. A. DELONG AND W. F. OLIVER. *Canad. J. Chem.*, **30**, 9–16 (*Jan.*, 1952).

Evidence concerning the forms of phosphorus-32 occurring in neutron-bombarded calcium phosphates has been obtained using carrier ions for the different forms, and estimations of the proportional amounts present in these forms have been made. Ortho-, hypo-, pyro- and metaphosphate forms of phosphorus-32 have been found as activity in the precipitation of the respective carriers; hypophosphate appeared to be an invariable and major component. A.

541.15 : 539.172.4

5398. Recoil reactions with high intensity slow neutron sources. I. The Szilard–Chalmers enrichment of 35·9 h Br^{82}. G. E. BOYD, J. W. COBBLE AND S. WEXLER. *J. Amer. Chem. Soc.*, **74**, 237–40 (*Jan.* 5, 1952).

Enriched 35·9 hr Br^{82} samples from a Szilard–Chalmers reaction in crystalline $KBrO_3$ (in the Oak Ridge graphite pile) showed specific activities up to 750 rd/mg, corresponding to a 22 000-fold enrichment. The variation of the specific activity with irradiation time and neutron source intensity agreed with an elementary theory based on the activation equation and the assumption that the rate of the non-activating radiation decomposition was proportional to the mass irradiated and to the intensity. The prediction that the specific activity will be independent of the source intensity and will increase with increasing time was confirmed, as was the predicted inverse dependence of the enrichment on source strength and time. The retention of radiobromine as bromate was found to increase with time, suggesting a radiation recombination may occur. A.

541.15 : 539.172.4

5399. Recoil reactions with high intensity slow neutron sources. II. The retention of radiobromine by crystalline $KBrO_3$. J. W. COBBLE AND G. E. BOYD. *J. Amer. Chem. Soc.*, **74**, 1282–6 (*March* 5, 1952).

Retention of radiobromine as bromate, during bombardment of crystalline $KBrO_3$ in the Oak Ridge graphite pile, increased from an apparent zero-time value of $9 \pm 1\%$ to a limit of $32 \pm 1\%$ after 16 hr irradiation. With the temperature at −195° during irradiation, the retention was $13 \pm 1\%$ beyond five minutes. Heating the irradiated $KBrO_3$ above 80° or exposing it to an energetic γ-ray source (Co^{60}) returned the radiobromine to bromate at a rate dependent on the temperature or source intensity respectively. No simple rate law could describe the thermal back-reaction; the radiation-induced reaction obeyed a first order velocity equation and showed an activation energy of *ca.* 8 kcal/mole. Theoretical estimates were made of the retention from "cage" effects and from the chance cancellation of γ-ray recoils. The constant retention observed in long-time neutron bombardments was attributed to a steady state between the rate of production of separable Br^{82} and the rate of its recombination to bromate by pile γ-rays and fast neutrons. A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.18.041.3

5400. Directed aggregation in colloidal systems, and the formation of protein fibers. A. L. G. Rees. *J. Phys. Coll. Chem.*, **55**, 1340–4 (*Nov.*, 1951).

A system consisting of a single spherical particle and a close pair of identical particles ("biparticle") is considered and the potential energy contours are calculated for the case where (i) there is a substantial potential-energy maximum for the interaction of two particles—a stable suspension, and (ii) the attractive potential is greater than the repulsive for all separations—an aggregating suspension. The contour diagram shows that (i) yields linear aggregates and (ii) yields two- and three-dimensional aggregates.

S. J. GREGG

541.183 : 536.66

5401. On the heats of adsorption of NH_3, PH_3 and AsH_3 on silica gel. J. Bastick. *C.R. Acad. Sci.* [*Paris*] **234**, 1279–8 (*March* 17, 1952) *In French.*

The heats of adsorption are measured by an ice calorimeter. Van der Waals' adsorption is involved for PH_3 and AsH_3, and chemi-adsorption for NH_3.

L. G. CARPENTER

541.183 : 536.7

5402. On basic concepts in surface thermodynamics. R. S. Hansen. *J. Phys. Coll. Chem.*, **55**, 1195–200 (*Oct.*, 1951).

It is shown that, for non-swelling solid adsorbents, the measured quantity of (*a*) gas adsorbed from the gaseous phase, or of (*b*) solute adsorbed from solution, is proportional to the Gibbsian excess and that the proportionality constant is experimentally determinable. A suggestion is made as to the most convenient location for the mathematical surface, for both (*a*) and (*b*). S. J. GREGG

541.183.53

5403. The adsorption on metal surfaces of long chain polar compounds from hydrocarbon solutions. S. G. Daniel. *Trans Faraday Soc.*, **47**, 1345–59 (*Dec.*, 1951).

A study of the adsorption on metal surfaces of long chain polar compounds from hydrocarbon solution has been made and in many cases the adsorption isotherms determined. With certain metals, notably copper, lead, zinc and cadmium, the isotherms could not be determined owing to reaction between the acid and oxide films on the metal surface. Except when reaction occurs, it is shown that the adsorption, which is reversible, is not appreciably affected by the nature of the metal substrate and that it is the properties of the adsorbate molecules which primarily determine the shapes of the isotherms. In general, ease of adsorption increases with increasing chain length and, for a given chain length, the acid is most strongly adsorbed and the ester least, with the alcohol intermediate. The influence upon adsorption of other factors such as temperature and solubility is discussed and in some cases it has been possible to calculate the free energy and heat of adsorption. When reaction between adsorbate and the metal surface occurs, it is the physical properties of the reaction products, the metal soaps, which determine the observed behaviour. A.

541.183.596

5404. Calculation of the adsorption behaviour of argon on octahedral potassium chloride. D. M. Young. *Trans Faraday Soc.*, **47**, 1228–33 (*Nov.*, 1951).

The potential energy of an isolated argon atom as a function of distance above the (111) plane of potassium chloride has been calculated at six different positions on the crystal surface, and heats of adsorption evaluated, following the method of Orr (1939). A.

CHEMICAL STRUCTURE 541.2/.6

541.553 : 539.133

5405. Directed valence in P_4 and As_4. M. Mashima. *J. Chem. Phys.*, **20**, 801–3 (*May*, 1952).

It has been reported that 3 best *spd* hybrid bond orbitals may be constructed at mutual angles of 73° 9′ and 133° 37′, but these bond orbitals have not been adapted to actual molecules. Trigonal pyramid bond orbitals can be obtained which have mutual angles of 73° 9′ and strength 3. When an angle between the directions of 3 equivalent bond orbitals is introduced as a parameter to these bond functions, variation of strength of these bond orbitals with the angle may be illustrated. These hybrid bond orbitals may be adapted to P_4 and As_4. It is reported that P_4 and As_4 molecules have bond angle 60°, the 4 atoms lying at the tetrahedron corners and the bonds along the tetrahedron edges. Hultgren has applied *pd* hybrid bond orbitals to such a configuration. Assuming that the *s* orbital is used in hybridization, stronger bond orbitals can be obtained than that by *pd* hybridization. Such *spd* trigonal pyramid bond orbitals have strength 2·970 (only slightly less than that of the best *spd* hybrid bond orbital) at bond angle 60°. It seems to be more probable that *spd* hybrid orbitals are used in the bond formation in P_4 and As_4 molecules; the unshared pair occupies the fourth hybrid orbital (containing all of the residual *s* parts) which has 76·5% *s* character at bond angle 60°. A.

541.57

5406. The effect of conjugation on bond dissociation energy. M. Szwarc and J. W. Taylor. *Trans Faraday Soc.*, **47**, 1293–8 (*Dec.*, 1951).

Dissociation processes of isomeric molecules leading to the formation of identical pairs of radicals are discussed. Four examples are provided. It is pointed out that, since the radicals produced are identical, the differences in the relevant bond dissociation energies reflect the influence of factors affecting the undissociated molecules only. These factors are discussed, and their relationship with respect to the bond length is stressed. The discussion leads to an assessment of the value D(NC–CN). The effect of a double bond on the dissociation energy of an adjacent bond is discussed with particular reference to $D(CH_2 : CH–H)$. A.

541.64 : 530.162

5407. Statistical mechanics of dilute polymer solutions. III. Ternary mixtures of two polymers and a solvent. W. R. KRIGBAUM AND P. J. FLORY. *J. Chem. Phys.*, **20**, 873–5 (*May*, 1952).

For Pt II, see Abstr. 9083 (1950). Expressions are derived for the osmotic pressure and turbidity of a dilute solution of two chemically dissimilar polymer species in a solvent. The relations obtained are contrasted with those derived through use of the free energy of mixing as given by the quasi-crystalline lattice model. Use of equations based on the lattice model to evaluate polymer-polymer interaction parameters from dilute solution data is shown to be valid only in special instances. A.

541.64 : 532.73

5408. High-polymer solutions. T. B. GRIMLEY. *Proc. Roy. Soc. A*, **212**, 339–61 (*May* 7, 1952).

The average dimensions of a chain with interactions are calculated by a statistical method. For $\langle s^2 \rangle$, the average square distance of the elements from the centre of gravity, the result is $\langle s^2 \rangle = (Nl^2/6)[1 - 0{\cdot}857(\beta_1/l^3)N^{-\frac{1}{2}}]$, where β_1 is the "excluded volume" integral for free chain elements. For large N this reduces to the well-known result for a random flight chain. Similar results are obtained for other average dimensions. The possibility of checking (i) from experimental determinations of $\langle s^2 \rangle$ for chain molecules using the light-scattering technique is examined, and it is shown that a very accurate knowledge of the chain-length distribution in the fractions used will be required if the influence of the second term in (i) is to be detected in this way. A natural extension of the statistical method is used to calculate the pair distribution function $F_2(X_{12})$ governing the probability of occurrence of the centres of gravity of two chains in equal volume elements separated by the distance X_{12}. This function is needed to calculate the second coefficient A_2 in the osmotic pressure expansion. A.

541.64 : 541.126

5409. Polymer formation in hydrocarbon flames. N. THOMAS. *J. Chem. Phys.*, **20**, 899–904 (*May*, 1952).

A theory is developed to account for certain experimental phenomena occurring in hydrocarbon flames. It postulates the formation of highly unsaturated chain-polymers and their subsequent rapid breakdown to active fragments and oxidation of these. The theory is applied to a number of examples of experimental data on hydrocarbon flames. A mathematical discussion of the breakdown of chain-polymers by self-oscillation is given, using a classical model, and the relation between the theory and the experimental data is discussed with reference to earlier work on unimolecular decomposition. A.

541.67

5410. Nuclear magnetic resonance spectra of some acid hydrates. R. E. RICHARDS AND J. A. S. SMITH. *Trans Faraday Soc.*, **47**, 1261–74 (*Dec.*, 1951).

Nuclear magnetic resonance spectra have been measured for the protons in the crystalline monohydrates of nitric, perchloric and sulphuric acids and in the dihydrate of oxalic acid at about 90°K. The absorption line for perchloric acid monohydrate at 0°C has also been obtained. The results show that the solid monohydrates of nitric, perchloric and sulphuric acids probably contain the oxonium ion (H_3O^+), and that oxalic acid dihydrate does not. The distance between the hydrogen atoms of the oxonium ion in nitric acid monohydrate is found to be $1{\cdot}72 \pm 0{\cdot}02$ Å and this is consistent with a pyramidal shape for the oxonium ion with OH bond lengths of about $1{\cdot}02$ Å. The narrow absorption line found for $HClO_4H_2O$ at 0°C indicates that the oxonium ion undergoes molecular reorientation in the crystal lattice at frequencies greater than about 50 kc/s. A.

CHEMICAL ANALYSIS 543/545

545.38

5411. Polarography with alternating currents. III. A.C. polarography of copper, bismuth, antimony, and tin with special reference to the presence of halogen ions. B. BREYER, F. GUTMANN AND S. HACOBIAN. *Aust. J. Sci. Res. A*, **4**, 595–603 (*Dec.*, 1951).

For Pt II, see Abstr. 5897 (1951). While Cu^{++}, Bi^{+++} and Sb^{+++} ions are irreversibly reduced in perchloric acid as supporting electrolyte, the electrode process becomes reversible when small amounts of halogen ions are added. It is shown that this cannot be explained by assuming the formation of complex halogeno metal ions. Sn^{++} ions in perchloric acid are reversibly reduced, but only in the presence of a large excess of chloride ions, indicating a reduction of the stannous tetrachloro complex ion ($SnCl_4^=$), as already observed by previous workers. A new polarographic cell design suitable for a.c. polarography (the "pool-condenser" saturated calomel electrode) is described. A.

545.38

5412. Polarography with alternating currents. IV. A.C. polarography of uranium, iron, nickel, and manganese. B. BREYER AND S. HACOBIAN. *Aust. J. Sci. Res. A*, **4**, 604–9 (*Dec.*, 1951).

Uranium was estimated in perchloric acid as the uranyl ion (UO_2^{++}); iron as the oxalato complex ion in neutral or acid oxalate. Nickel and manganese were estimated as cyano complexes which are reversibly reduced at the dropping mercury electrode. A.

545.38

5413. Polarography with alternating currents. V. A.C. polarography of some common anions. B. BREYER AND S. HACOBIAN. *Aust. J. Sci. Res. A*, **4**, 610–15 (*Dec.*, 1951).

The a.c. polarography of Cl^-, Br^-, CNS^-, OH^-, $SO^=$, CN^- and $S^=$ is discussed. Chloride, bromide, hydroxide and sulphide ions were estimated quantitatively by a.c. polarography in suitable supporting electrolytes. The anodic a.c. waves present the following characteristic features: (i) They are asymmetric and much sharper than the usual cathodic a.c. waves. (ii) The summit potentials do not correspond to the relative half-step potentials but occur at voltages corresponding to the commencement of the

anodic discharge. (iii) In contrast to cathodic a.c. polarography the anodic a.c. electrode processes strongly interfere with one another; the wave height of a given anion species is greatly reduced in the presence of anions dischargeable at more negative potentials. A.

545.8 : 539.16.08

5414. Radiochemical studies on free radicals. A. Hollis and F. A. Paneth. Letter in *Nature* [*Lond.*] **169,** 618 (*April* 12, 1952).

Describes an improved technique of studying free radicals, using a radioactive mirror combined with a Geiger counter; RaE was used as indicator for a heavy Bi mirror. F. LACHMAN

545.82

5415. A light absorption method for the quantitative determination of small changes in chlorine concentration. A. D. Krumbein, F. A. Grant and A. L. Ward. Letter in *J. Opt. Soc. Amer.*, **42,** 277–8 (*April*, 1952).

An illustrated description of a photoelectric absorptiometric apparatus for measuring small changes in the concentration of the Cl component in the counter filling, using a simplified Beer's law expression $I = I_0(1 - \alpha cd)$ which has been found to be valid up to a Cl pressure of 3 mm Hg. F. LACHMAN

545.82 : 535.342

5416. Light absorption spectrometry. M. G. Mellon. *Analyt. Chem.*, **24,** 2–8 (*Jan.*, 1952).

Annual review. 291 refs.

545.82 : 535.342–15

5417. Infrared spectroscopy. R. C. Gore. *Analyt. Chem.*, **24,** 8–13 (*Jan.*, 1952).

Annual review. 419 refs.

545.82 : 535.342–31

5418. Ultraviolet absorption spectroscopy. E. J. Rosenbaum. *Analyt. Chem.*, **24,** 14–16 (*Jan.*, 1952).

Annual review. 61 refs.

545.824

5419. Application of X-ray spectrometry to the estimation of small concentrations of metals in minerals. J. Despujols. *J. Phys. Radium*, **13,** 31A–41A (*Feb. Suppl.*, 1952) *In French.*

Three methods are discussed: emission spectra with fluorescent excitation; emission spectra with electron excitation, and absorption spectra. The best results for industrial application are obtained by the first of these, of which a detailed study is given. The method was applied to the determination of zinc, with an accuracy of 5–10% in concentrations of the order of one part in a thousand. R. S. PEASE

545.824 : 537.531 : 535.34

5420. X-ray absorption. H. A. Liebhafsky. *Analyt. Chem.*, **24,** 16–20 (*Jan.*, 1952).

Determination of tetraethyl lead fluid in gasoline; review.

545.824 : 537.531 : 535.42

5421. X-ray diffraction. H. S. Kaufman and I. Fankuchen. *Analyt. Chem.*, **24,** 20–2 (*Jan.*, 1952).

Review of analytical applications, and new apparatus and techniques. 114 refs.

545.827

5422. Mass spectrometry. V. H. Dibeler and J. A. Hipple. *Analyt. Chem.*, **24,** 27–31 (*Jan.*, 1952).

Review of analytical applications. 222 refs.

545.828 : 535.33

5423. Emission spectroscopy. W. F. Meggers. *Analyt. Chem.*, **24,** 23–7 (*Jan.*, 1952).

Review of analytical applications for 1950–51. 139 refs.

CRYSTALLOGRAPHY 548

548.0

5424. Transformation properties of the physical constants of crystals. H. Juretschke. *Acta Cryst.*, **5,** 148–9 (*Jan.*, 1952).

An improved method is suggested for transforming to an arbitrary co-ordinate system the material constants given with respect to a particular orthogonal co-ordinate system oriented according to the crystal symmetry. Co-ordinate products are used, which is of advantage in determining physical constants symmetric in some indices. C. TURNER

548.0 : 539.32

The elastic behaviour of a crystalline aggregate. *See Abstr.* 5356

548.24

5425. Energy absorption during twin formation in zinc single crystals. E. I. Salkovitz. Letter in *Phys. Rev.*, **85,** 1046 (*March* 15, 1952).

The energy per unit volume of twin was measured by the ballistic pendulum method on 99·999% pure Zn crystals. It increases with decreasing temperature, and at room temperature is less the more nearly the basal plane is normal to the specimen axis.

A. D. LE CLAIRE

548.5

5426. Studies in the growth and habit modifications of crystals. H. E. Buckley. *Mem. Manchr. Lit. Phil. Soc.*, **92,** 77–123 (1950–51).

A table for the habit modifying power of about 500 water-soluble dyes on different crystal surfaces of KCl, K_2CrO_4, NH_4ClO_4, $K_2Cr_2O_7$, potash alum and borax. With comments, a list of powerful modifiers, and 17 references. C. TURNER

548.5

5427. Derivation of the parabolic law of surface layer growth. K. Lücke. *Nachr. Wiss. Göttingen, Math.-phys. Kl. IIa, No.* 4, 5 *pp.* (1951) *In German.*

The author believes that the postulate of a stationary diffusion process (a constant diffusion current across each layer section), involving a linear concentration gradient in the growing film on a metal, is only a first approximation. Yet, when assuming a variable concentration gradient depending upon the

diffusion process, the parabolic law ($s = k\sqrt{t}$, where s is the film thickness and t, time) is again obtained, irrespective of whether the diffusion constant is or is not dependent on concentration. F. LACHMAN

548.5

5428. Growth and crystallography of deformation of β-phase uranium single crystals. A. N. HOLDEN. *Acta Cryst.*, **5**, 182–4 (*March*, 1952).

Single crystals of the tetragonal β-phase of uranium were grown in material containing small amounts of chromium by a $\gamma \rightarrow \beta$ phase-transformation method. These crystals could be retained in a metastable condition for long periods following their quenching from normal β-phase temperatures into water at room temperature. The crystals were found to be ductile, with slip occurring on the {110} type plane in the ⟨001⟩ direction, a slip system analogous to that of β (tetragonal) tin. A.

548.5

5429. Oriented overgrowths of alkali halides on silver substrates. L. G. SCHULZ. *Acta Cryst.*, **5**, 266–8 (*March*, 1952).

CsCl, CsBr, LiF, NaCl, NaBr, KCl, RbBr and KI were deposited from the vapour phase and from solution on oriented silver films. Electron diffraction was then used to determine the orientation of the crystals in these alkali halide deposits. In growth from the vapour both NaCl- and CsCl-type salts oriented with planes containing only metal ions (or only non-metal ions) parallel to the plane of the substrate. The angular position tended to be consistent with best atomic matching at the interface. In growth from solution a greater variety of orientations occurred, including those in which mixed-ion planes were parallel to the substrate. The interaction between the deposit and substrate was sufficiently strong to induce polymorphism of CsCl, CsBr and RbBr. Growth from solution often gave orientations different from those given in growth from the vapour. A.

548.5

5430. Regular orientations of dimethyl-glyoxime on various supporting crystals. J.-C. MONIER. *C.R. Acad. Sci.* [*Paris*] **234**, 1185–6 (*March* 10, 1952) *In French.*

Dimethyl-glyoxime sublimes easily on to planes of ionic crystals. It is found that the crystallites orientate themselves in such a way, that the *b*-axis is parallel to that direction in the supporting crystal along which the distance between atoms is, or is a multiple of, the lattice unit along this axis (6·39 Å). A. J. TAYLOR

548.51

5431. On the creation of centres of crystallization [nucleation] in supercooled liquids. XI. The growth of centres on activated impurities. V. I. DANILOV AND D. E. OVSIENKO. *Zh. Eksper. Teor. Fiz.*, **21**, 879–86 (*No.* 8, 1951) *In Russian.*

For Pt X, see Abstr. 3501 (1950). The growth of centres of crystallization of Bi and Sn metals on particles of their oxides is described, as is also the oriented growth of crystals from supercooled hydroquinone on plates of calcite. The rate of nucleation in supercooled metals depends (in the presence of oxides) on the previous degree of superheating, the centres becoming deactivated by heating. Some residual activity survives superheating. The log of the rate of nucleation depends linearly on $(1/T)\Delta T^2$, where ΔT is the amount of supercooling. The log of the rate is 10× as great for pure metals as for the oxidized metals. A. L. MACKAY

548.52

5432. A theory of crystal morphology. P. HARTMAN AND W. G. PERDOK. *Proc. K. Ned. Akad. Wet. B*, **55**, 34–9 (*No.* 2, 1952).

The morphology of a crystal is governed by a set of periodic bond chains; those chains which contain the strongest bonds are the more important. This does not always imply that in these chains also the shortest distances between building units are found. Separate bonds, which do not form chains, cannot exert any influence on the morphological development. A.

548.53

5433. X-ray investigation of the thermal decomposition of dolomite crystals. R. A. W. HAUL AND HEINZ WILSDORF. *Acta Cryst.*, **5**, 250–5 (*March*, 1952) *In German.*

This was carried out using single-crystal methods. After complete decomposition to the first stage of reaction, i.e. MgO and $CaCO_3$, the X-ray diagrams exhibit homogeneous powder patterns of MgO and, most remarkably, single-crystal patterns of $CaCO_3$. These result from calcite crystallites oriented in the same way as the original dolomite. During decomposition the lattice order of the ever-decreasing dolomite crystal is maintained in all respects. The calcite powder patterns obtained predominantly at high temperatures (e.g. 800°C) indicate recrystallization effects. On the basis of these findings a reaction mechanism is propounded involving the direct formation of calcite from the dolomite lattice. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

5434. Normal frequencies of a simple cubic lattice. III. J. O. HALFORD. *J. Chem. Phys.*, **20**, 822–4 (*May*, 1952).

For Pts I and II, see Abstr. 638 (1952). For a simple cubic crystal, with forces resisting displacement along and perpendicular to the connecting line between closest neighbours, the secular equation for the internal motions is rigorously broken down to ultimate factors of the form $\nu^2 = \nu_x^2 + \alpha(\nu_y^2 + \nu_z^2)$, in which ν_x, etc., are the normal frequencies of the one-dimensional crystal. The corresponding frequency distribution shows no indication of the "infinities" found by Montroll for a model with central forces between first and second neighbours. A.

548.7 : 535.43

5435. Molecular scattering of light in crystals. G. P. MOTULEVICH. *Trudy Fizicheskogo Instituta P.N. Lebedeva, Vol. 5. Moscow, Akademii Nauk, SSSR* (1950) *pp.* 9–62.

Doctorate thesis presented at the Lebedev Physical Institute.

548.7 : 537.311.32

5436. On the states of a conduction electron in an ideal homopolar crystal. M. F. Deĭgen and S. I. Pekar. *Zh. Eksper. Teor. Fiz.*, **21**, 803–8 (*No.* 7, 1951) *In Russian.*

The possibility is considered of local elastic deformations of a crystal by the field of an electron and of the localization of the electron in the neighbourhood of the deformation. It is shown that such self-localization of the electron does not exist in the approximation of a crystal-continuum, but appears in a more detailed (atomic) model of the crystal if an appropriate inequality is satisfied, in which case the energy of the self-localized state is less than that of the free electron in the conduction zone.

W. J. SWIATECKI

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 5346–51

548.732

5437. The reflexion and transmission of X-rays in perfect absorbing crystals. P. B. Hirsch. *Acta Cryst.*, **5**, 176–81 (*March*, 1952).

The absorption of X-rays diffracted by perfect crystal slabs is discussed in terms of the dynamical theory of X-ray diffraction for perfect absorbing crystals. This theory is presented in a form suitable for comparison with experiments. The experimental results of Borrmann are interpreted, and found to be in good quantitative agreement with the theory. Some observations by Campbell are also discussed. A.

548.732

5438. Scattering from cylindrically symmetric systems. G. Oster and D. P. Riley. *Acta Cryst.*, **5**, 272–6 (*March*, 1952).

Expressions for the intensity of scattering by systems composed of infinitely long cylindrical particles are derived. Four types of independent scattering regions are considered: (1) isolated cylindrical rods, with and without internal radial structure; (2) aggregates of parallel rods with fixed locations; (3) systems of parallel rods with variable locations; (4) two-dimensional crystals. The effect of random and specific orientation of independent scattering regions is discussed. The results are applicable to low-angle X-ray scattering from fibres and from macromolecular or micellar solutions. A.

548.732 : 537.531 : 535.34

5439. The transmission of X-rays at settings near the Bragg angle. G. N. Ramachandran. Letter in *J. Appl. Phys.*, **23**, 500 (*April*, 1952).

The experimental results of Campbell [Abstr. 9821 (1951)] are shown to be in agreement with results calculated from the theory of von Laue [Abstr. 4012 (1949)]. A. R. STOKES

548.733

5440. Furnace construction and thermocouple arrangements for a high temperature X-ray camera. Z. S. Basinski, W. B. Pearson and J. W. Christian. *J. Sci. Instrum.*, **29**, 154–5 (*May*, 1952).

Modifications to a high temperature camera enable the actual specimen temperature to be measured accurately in the range 700–1000°C. The maker's furnaces have been replaced by hemispherical furnaces and the temperatures are measured and controlled by means of two rigidly fixed ring thermocouples of new design. Reproducible results have been obtained and it has been shown that the gradients in the specimen and the difference in temperature between specimen and thermocouples are both very small. A.

548.734

5441. A stroboscopic effect in the X-ray analysis of crystalline aggregates. H. J. Goldschmidt. *Acta Cryst.*, **5**, 256–9 (*March*, 1952).

An X-ray diffraction technique is described, based on the observation of a stroboscopic effect which results from synchronism between the speed of specimen rotation and the pulse frequency of the incident X-ray beam. The effect consists in regular striations occurring at inclinations varying amongst diffraction spots; these striations can be caused to disappear by heat-treatment. Structural details of a crystalline mass are revealed, which would otherwise not be apparent. A photograph showing striations gives simultaneously the orientation and lattice spacing of a given crystallite, and allows a differentiation between different crystal sizes. Contributions to the background intensity from individual reflecting planes can be distinguished, thus helping the determination of the true width of a given line, visually or by photometry. One potential application is to distinguish between strain and small particle size as causes of line broadening. A.

548.735.2

5442. A general method of solving crystal structures of symmetry D_{2h}^{16} [Pnma]. N. V. Belov and V. I. Mokeeva. *Dokl. Akad Nauk, SSSR*, **81**, 187–90 (*No.* 2, 1951).

Many important minerals and synthetic inorganic and organic compounds crystallize with the space group *Pnma* (*Pbnm* in the mineralogical orientation). Conditions are particularly favourable for solution as the heavier atoms generally lie in special positions on the mirror planes. Three Patterson–Harker sections (at $z = \frac{1}{2}$, etc.) give the positions of the heavier atoms, then a Fourier projection on to a mirror plane and a Fourier section halfway between the mirror planes are recommended for finding the remaining atoms. The application of the method to a new structure (ilvite) and to the verification of the structure of olivine will be published later.

A. L. MACKAY

548.735.7 : 539.215.2

A dynamical model of a crystal structure. Grain boundaries. *See Abstr.* 5344

548.736.1

5443. The anisotropy of the atomic scattering factor for X-rays in crystals of aluminium and diamond. S. T. Konobeevskiĭ and K. P. Mamedov. *Zh. Eksper. Teor. Fiz.*, **21**, 953–63 (*No.* 9, 1951) *In Russian.*

Information on the shape of atoms in a crystal lattice can be obtained from comparisons of the intensities of certain diffraction maxima. Using the Laue method it was shown that the intensity of the 333 reflection in Al is about 10% greater than that of the 511 reflection which corresponds to a thinning of the electron cloud of the Al atoms in the octahedral

directions and a thickening in the cube directions. For diamond the forbidden reflections 222 and 622 were observed and the reflections 420 and 422 were found to be absent. This shows the electron structure of diamond to be similar to that of crystobalite in which the O atoms are replaced by spherical charges of 0·12*e* having diameters of approx. 0·5 Å.

A. L. MACKAY

548.736.1

5444. The crystal structure of β-monoclinic selenium. R. D. BURBANK. *Acta Cryst.*, **5**, 236–46 (*March*, 1952).

This was determined by the application of the Harker–Kasper phase inequalities and two-dimensional Fourier syntheses. The β-Se molecule is an eight-membered chain with the configuration of a puckered ring molecule in which one of the bonds has been broken. At one end of the chain the terminal atom and its neighbour are nearly double-bonded. The remaining 6 bonds in the chain are approximately single bonds. At several points in each molecule there are unusually strong interactions with neighbouring molecules. About 7·7 electron pairs are utilized for bonding within the molecule while 0·3 electron pairs are engaged in intermolecular bonding. Diffraction data have been obtained which demonstrate that a single crystal of β-Se can transform directly into a single crystal of metallic Se. During the transition the molecules are broken down into smaller fragments which recombine to form the infinitely long helical chains of metallic Se. Relations between mixed crystals of S and Se, and between the various polymorphs of Se are discussed. A.

548.736.3

5445. The structure of pyrrhotite Fe_7S_8. F. BERTAUT. *C.R. Acad. Sci.* [*Paris*] **234**, 1295–7 (*March* 17, 1952) *In French.*

The crystal is investigated by X-ray experiments. It is found that the space group is $C_{2h}^6 - C_c^2$ and that the stoichiometric formula is Fe_7S_8, not $Fe_{1-\varepsilon}S$ as has been assumed. The vacant lattice sites in the crystal are regularly spaced. A. J. TAYLOR

548.736.4 : 539.133

The structure of chlorine hydrate. *See Abstr.* 5247

548.736.6

5446. Developments in silicon carbide research. L. S. RAMSDELL AND J. A. KOHN. *Acta Cryst.*, **5**, 215–24 (*March*, 1952).

An additional five new types of SiC are described, and their unit-cell dimensions and atomic arrangements given. In order to explain the astounding number of polymorphs of SiC (now 14 fully-described types), it is postulated that in the growth of SiC by sublimation, there are formed certain clusters of atoms (polymers), each characterized by a particular temperature stability range. At a given characteristic temperature, a single type of polymer would produce a "pure" type, with the sequence consisting of identical pairs. If stability ranges overlap, two polymers might exist simultaneously, resulting in a "mixed" type. Variations in the proportions of the two polymers present would produce types composed of the same polymers, but in differing proportions. It would not be possible to have three polymers stable simultaneously, hence no type should be composed of more than two polymers. A.

548.737 : 539.133

The external form of the haemoglobin molecule. *See Abstr.* 5254

548.74

5447. On two-dimensional electron interference on transmission through thin metal layers. H. RAETHER. Note in *Z. Naturforsch.*, **7a**, 210 (*Feb.*, 1952) *In German.*

Transmission electron diffraction photographs of heat-treated AuCu and $AuCu_3$ alloys show narrow streaks connecting some spots to the origin.

A. R. STOKES

548.74

5448. Observations on the photoelectric work functions and low speed electron diffraction from thin films of silver on the (100) face of a silver single crystal. E. N. CLARKE AND H. E. FARNSWORTH. Letter in *Phys. Rev.*, **85**, 484–5 (*Feb.* 1, 1952).

Discusses the conditions under which the evaporation of Ag on the (100) face of a Ag crystal results in the lowering of the photoelectric work function. It is shown by electron diffraction that the crystal structure and orientation of the deposited film are the same as those of the supporting crystal. J. THEWLIS

548.74

5449. The disappearance of electron diffraction patterns after prolonged exposure. H. FRISBY. *C.R. Acad. Sci.* [*Paris*] **234**, 1137–8 (*March* 10, 1952) *In French.*

The time t in days of disappearance of the pattern given by an electrolytically polished Cu surface is related to the absolute temperature θ by the expression $\log_{10} t = h - 0{\cdot}0055\theta$, where h is between 2·1 and 2·3. The disappearance, which is not due to the deposition of grease, to the formation of an amorphous oxide layer, or to adsorption of gas, may be due to the broadening and disappearance of small asperities on the surface, from which, at glancing incidence, the pattern must be in the main reflected. R. S. PEASE

548.74

5450. A single crystal neutron diffraction determination of the hydrogen position in potassium bifluoride. S. W. PETERSON AND H. A. LEVY. *J. Chem. Phys.*, **20**, 704–17 (*April*, 1952).

Neutron diffraction measurements on KHF_2 single crystals show that the H atom occupies the central position, within 0·1 Å, in the linear F — H — F ion. The data also indicate asymmetry in thermal motion, which suggests that the bifluoride ion undergoes rotatory oscillation with appreciable amplitude. The study demonstrates the usefulness of single crystal neutron diffraction data for crystal structure determination. A.

548.74

5451. Extinction effects in neutron transmission of polycrystalline media. R. J. WEISS. *Phys. Rev.*, **86** 271–5 (*May* 1, 1952).

The effects of primary and secondary extinction are considered for neutron transmission work in the energy region where diffraction is important. It is

shown that in typical studies the grain size is the most important parameter affecting extinction, with the mosaic block size and the angular spread of the mosaic blocks of secondary importance. Experiments were performed to corroborate the theory, and criteria are set up to avoid extinction effects. It is shown how to determine the mosaic block size and the angular spread of the mosaic blocks in substances with large grain size by using fine resolution near the last crystalline cutoff, where the breadth of the Bragg peak becomes large compared to the angular misalignment of the mosaic blocks. A.

GEOPHYSICS 55

550.3 : 539.16.08

5452. The radioactivity of the Hercynian Vosges. J.-P. ROTHE AND E. PETERSCHMITT. *C.R. Acad. Sci. [Paris]* **234** 1610–12 (*April* 16, 1952) *In French.*

Measurements of radioactivity with a γ-meter and ionization chamber have been made at 205 stations which were accurately surveyed. The results have been plotted on a map of the region and it has been possible to extract both general conclusions and also those specific to this region. In general the activity is fairly constant throughout a homogeneous petrographic area and also there is a strong correlation with the potassium content. J. M. HOUGH

550.38 : 538.221

Reverse thermo-remanent magnetism. *See Abstr.* 5192

ATMOSPHERE . METEOROLOGY 551.5

551.508.7

5453. Apparatus for the determination of moisture in samples of air. R. S. VINCENT. *J. Sci. Instrum.*, **29**, 155–7 (*May*, 1952).

A sample of air, 85 cm³ or more in volume, is taken into an evacuated flask, which is subsequently connected to the measuring apparatus and the water vapour pressure measured manometrically by absorption in phosphorous pentoxide. The success of the method depends on freezing the moisture temporarily on the inner surface of the flask, thus permitting almost complete separation of the air from the moisture to be measured. A.

551.510.4

5454. Preliminary report on atmospheric ozone measurements from rockets. J. A. VAN ALLEN AND J. J. HOPFIELD. *Mem. Soc. Roy. Sci. Liège*, **12**, 179–83 (*No.* 1–2, 1952).

The technique is described, and results are tabulated as total O_3 cm N.T.P. vertically above a series of altitudes ranging from 25 to 60 km in 5 km steps. D. R. BARBER

551.510.4

5455. The average atmosphere up to 220 km. R. J. HAVENS AND H. E. LAGOW. *Mem. Soc. Roy. Sci. Liège*, **12**, 185 (*No.* 1–2, 1952).

Basic physical data are tabulated for altitudes up to 160 km (in 10 km steps) based on observations from 10 rocket flights at White Sands, New Mexico. D. R. BARBER

551.510.535 : 538.566.

Radio-wave propagation in the ionosphere. *See Abstr.* 5210

551.513 : 551.593.

5456. The spectrum of turbulence in the earth's upper atmosphere. C. DE JAGER. *Mem. Soc. Roy. Sci. Liège*, **12**, 223–52 (*No.* 1–2, 1952).

The distribution of turbulent velocities in the upper atmosphere, shown by persistent meteor trains, is found to obey Kolmogorov's law for distances < 10 km. The turbulence spectrum at 100 km level is derived for two atmospheric models based on (i) optical and ionospheric, and (ii) rocket data. It is suggested that atmospheric turbulence may provide an additional source of the energy necessary to produce and maintain the nightglow. D. R. BARBER

551.593.

5457. Brief description of work on the infrared transmission of the earth's atmosphere. R. ANTHONY. *Mem. Soc. Roy. Sci. Liège*, **12**, 161–4 (*No.* 1–2, 1952).

Recent spectrophotometric measures in the region 9–12 μ, indicate that Lambert's law is valid up to 7·0 cm precipitable H_2O. Beyond 10 μ i.r. solar radiation appears in excess of that expected for a full radiator at 6 000°K. D. R. BARBER

551.593.

5458. Recent progress in the observation of the solar infrared spectrum at Jungfraujoch (Switzerland). M. MIGEOTTE AND L. NEVEN. *Mem. Soc. Roy. Sci. Liège*, **12**, 165–78 (*No.* 1–2, 1952) *In French.*

The following i.r. absorption bands have been identified on grating spectrograms of the region 1 μ to 20 μ: CH_4—3·3, 3·53, 3·84, 7·7; N_2O—2·87, 2·97, 3·57, 3·9, 4·06, 4·5, 7·8, 8·6; CO_2—4·8, 5·2, 9·4, 10·4, 13·9; CO—4·6; HDO—3·7; O_3—9·6 μ. D. R. BARBER

551.593.

5459. On the absolute absorption of radiation by molecular N and O between 3000 Å and 13 000 Å. G. L. WEISSLER. *Mem. Soc. Roy. Sci. Liège*, **12**, 281–94 (*No.* 1–2, 1952).

Absolute absorption coeffs. for N_2 and O_2 have been determined in the far u.v. In all cases, Beer's law holds within *c.* 10% over the range of gas pressure used. D. R. BARBER

551.593.5 : 551.594.

5460. Atomic and molecular N in the high atmosphere. M. NICOLET AND R. PASTIELS. *Mem. Soc. Roy. Sci. Liège*, **12**, 147–9 (*No.* 1–2, 1952).

New evidence is given for presence of atomic N in the upper atmosphere, both from observation of

[N I] and [N II] lines in auroral spectra; and from certain theoretical considerations of the ionized layers. D. R. BARBER

551.593.9

5461. The optical study of the terrestrial atmosphere. *Mem. Soc. Roy. Sci. Liège*, **12**, 319 *pp.* (*No.* 1–2, 1952).

Communications presented at an International Colloquium held at Liège, 3–5 September, 1951. For abstracts see Abstr. 2304, 5454–5, 5456–60, 5462–71, 5473–6 (1952).

Papers not abstracted: *Introduction.* E. P. Swings (9–12. In French). *The interpretation of some former measures.* A. Vassy and E. Vassy (57–61. In French). *On some problems relative to the dioptrics of the twilight rays.* F. Link (151–4. In French). *Some theorems relative to twilight effects in the high altitude luminescent layer.* F. Link (155–60. In French). *The variation of intensity with height for the light from an auroral arc.* D. K. Berkey and C. W. Gartlein (199–201). *Suggestions for new photoelectric observations of the zodiacal light and the counterglow.* P. Swings (215–22). *Approximate analytical solution of Poeverlein's problem.* E. Argence (253–67. In French). *Measures of the number of collisions in regions E and F2 of the ionosphere.* K. Rawer, K. Bibl and E. Argence (269–80. In French). *Spectrum of N_2 in the photographic infrared.* L. Herman and R. Herman (303–4. In French). *Heats of dissociation of NO and N_2.* B. Rosen (317–19. In French).

551.593.9

5462. Excitation patterns in the nightglow. F. E. ROACH AND H. B. PETTIT. *Mem. Soc. Roy. Sci. Liège*, **12**, 13–42 (*No.* 1–2, 1952).

A synoptic photometric study of the nightglow at 5577 Å, 5893 Å and 6300 Å, based on systematic photoelectric observations in the Mojave Desert, Calif., 1948–51. See also Abstr. 2302, 2305 (1952).

D. R. BARBER

551.593.9

5463. The altitude of the emission layers of the night-sky. D. BARBIER. *Mem. Soc. Roy. Sci. Liège*, **12**, 43–56 (*No.* 1–2, 1952) *In French.*

Five tables summarize heights of emitting layers in the terrestrial atmosphere observed to date by various methods and investigators. They comprise data for the following radiations: continuum; Vegard–Kaplan bands of N_2; Herzberg and atmospheric bands of O_2; Meinel bands of OH; [Na I] 5893 Å; [O I] 5577 Å; and [O I] 6300 Å. D. R. BARBER

551.593.9

5464. Absolute measurements of night-sky brightness at high altitudes, and comparison with measures at ground level. H. GARRIGUE. *Mem. Soc. Roy. Sci. Liège*, **12**, 63–70 (*No.* 1–2, 1952) *In French.*

Comparison of measurements made with a visual (binocular) photometer on air flights at 8500 m with those made at mountain sites, 1500–3000 m, and near sea-level in polar regions yield the following percent. absorption values in lower layers of atmosphere, for very clear skies:—blue: zenith 10%, horizon 32%; green: 10%, 25%; red: 5%, 12%. D. R. BARBER

551.593.9

5465. Theoretical altitudes of the nocturnal emission layers. M. NICOLET. *Mem. Soc. Roy. Sci. Liège*, **12**, 71–86 (*No.* 1–2, 1952) *In French.*

The principal atomic and molecular emissions of twilight and night skies are interpreted theoretically, and an upper altitude limit of 200 km deduced.

D. R. BARBER

551.593.9

5466. The height of the luminescent Na layer in the upper atmosphere. Criticism of the 'zenith–horizon' method. J. BRICARD AND A. KASTLER. *Mem. Soc. Roy. Sci. Liège*, **12**, 87–96 (*No.* 1–2, 1952) *In French.*

Photographic, and other systematic sources of error involved in Vegard's method of deducing the height of Na emission from twilight spectra are discussed. It is found that the height is over-estimated by *c.* 33 km [see also Abstr. 2279 (1952)]. D. R. BARBER

551.593.9

5467. A photometric investigation of the sky-light from sunset to sunrise. J. HOUTGAST. *Mem. Soc. Roy. Sci. Liège*, **12**, 117–34 (*No.* 1–2, 1952).

The nocturnal distribution of intensity distribution in the continuous spectrum of scattered sunlight has been derived by photographic photometry in 3 azimuths at 43° altitude. A fast spectrograph with Schmidt camera was used. The abs. intensity of [O I] emission at 5577 Å was computed as equiv. width of solar spectrum at the same wavelength by comparison of n–s spectrum with that of full-moon. No. of quanta emitted at 5577 Å were $4{\cdot}4\times10^8$/sec in agreement with result of Roach and Pettit [Abstr. 2305 (1952)]. D. R. BARBER

551.593.9

5468. Brightness of the twilight sky. M. J. KOOMEN, C. LOCK, D. M. PACKER, R. SCOLNIK AND E. O. HULBERT. *Mem. Soc. Roy. Sci. Liège*, **12**, 135–40 (*No.* 1–2, 1952).

Precision observations of sky brightness have been made throughout twilight for clear skies, and atmosphere fairly free from haze. A plot of zenith-sky brightness *v.* solar depression, D, shows no changes of slope at $D = 6$, 8, 10 and 12 degrees, as reported by Vaucouleurs [Abstr. 3237 (1951)]. D. R. BARBER

551.593.9

5469. Excitation of the ^4S–^2D line of atomic N in the upper atmosphere at twilight. M. DUFAY. *Mem. Soc. Roy. Sci. Liège*, **12**, 141–6 (*No.* 1–2, 1952) *In French.*

The forbidden [N I] emission at 5199 Å has been obsd. systematically at twilight, and during the night with a Cojan spectrograph, $f\,0{\cdot}65$. In early twilight, $D_\odot < 11°$, and during night, the line is rarely photographed; but appears consistently on plates exposed during twilight interval, $11{\cdot}6° < D_\odot < 13{\cdot}3°$.

D. R. BARBER

551.593.9

5470. Laboratory studies related to the physics of the upper atmosphere. J. KAPLAN. *Mem. Soc. Roy. Sci. Liège*, **12**, 295–302 (*No.* 1–2, 1952).

Based on recent work, several mechanisms are examined which may throw light on the mode of origin of the Vegard–Kaplan, Meinel (OH), and

Kaplan–Meinel bands in the emission spectrum of the nightglow. Metastable O_2, responsible for Kaplan–Meinel bands in the i.r. nightglow, may play an important part in the atmospheric O_3 problem. D. R. BARBER

551.593.9

5471. The analysis of molecular excitation processes. R. W. NICHOLLS. *Mem. Soc. Roy. Sci. Liège*, **12**, 305–16 (*No.* 1–2, 1952).

Excitation processes occurring in spectral sources are treated analytically to predict the dependence of emitted radiation upon the physical conditions at the source. The method is applied to band systems from glow discharges in N_2, and air. D. R. BARBER

551.593.9

5472. Emission of the atmospheric oxygen bands in discharges and afterglows. L. M. BRANSCOMB. Letter in *Phys. Rev.*, **86**, 258 (*April* 15, 1952).

Note on production of forbidden atmospheric bands in pure O_2 electrodeless discharge, and (less intense) in afterglow. The vibrational and rotational temps. derived from each process agree, and therefore place confidence in application to the estimation of the temp. of the airglow emitting layer [Abstr. 2225, 3993 (1951)]. G. M. BROWN

551.594.5

5473. Identification of O_2^+ bands and forbidden N in auroral spectra. C. W. GARTLEIN AND D. F. SHERMAN. *Mem. Soc. Roy. Sci. Liège*, **12**, 187–90 (*No.* 1–2, 1952).

Band features in range, 5198–5300 Å, are matched with "synthetic" spectra and identified as belonging to (2 0) band of 1st neg. system of O_2^+. Bands and lines of N_2^+, [N I], and [N II] have also been detected. All these features are present in strong aurorae. D. R. BARBER

551.594.5

5474. First positive bands of N in auroral spectra. C. W. GARTLEIN AND G. SPRAGUE. *Mem. Soc. Roy. Sci. Liège*, **12**, 191–3 (*No.* 1–2, 1952).

Except for [O I] lines and H_α, the +ve N_2 bands are most prominent features of grating spectra, 5500–6800 Å, dispersion 128 Å/mm. The 5·2 band at 6705 Å is most intense, with 4·1 and 6·3 bands at 6789 and 6624 Å nearly as strong. Separation between 1st band-head and 1st max. of various bands agree within ±0·5 Å for any one plate, but vary from plate to plate, separation being greatest when H_α is most intense, indicative of higher rotational temperatures during influx of H atoms. D. R. BARBER

551.594.5

5475. The appearance of H in auroral spectra, 1942–51. C. W. GARTLEIN. *Mem. Soc. Roy. Sci. Liège*, **12**, 195–8 (*No.* 1–2, 1952).

Data obtained from a statistical study of low dispersion spectrograms indicate the reality of auroral H radiation. D. R. BARBER

551.594.5

5476. Excitation mechanisms in the aurora. A. B. MEINEL. *Mem. Soc. Roy. Sci. Liège*, **12**, 203–13 (*No.* 1–2, 1952).

For the first time, evidence has been obtained of Doppler displacements at H_α(6562 Å). The asymmetric violet wing extends *c.* 70 Å (at 1/10 int. level) on spectrograms exposed in the magnetic zenith. Profile asymmetry is typical of energetic particles in absorbing media. D. R. BARBER

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843.45

5477. Chromatic aberration in the eye. S. F. JACOBS AND A. B. STEWART. Letter in *Amer. J. Phys.*, **20**, 247–8 (*April*, 1952).

If an opaque object is held against a white background within the least distance of distinct vision, coloured fringes due to chromatic aberration can be observed. If the object is one's finger, the effect can be imitated and followed in a class-room. A simple lens is used to reproduce and explain the effect on a large scale. Two figs. R. A. WEALE

612.843.61 : 621.397.81

5478. A graphical treatment of the tone reproduction problem in television systems. R. B. MACKENZIE. *Brit. J. Appl. Phys.*, **3** 141–7 (*May*, 1952).

The impracticability of analysing the tone reproduction properties of a television system in terms of simple mathematical laws is discussed. A construction for a tone reproduction chart is presented which enables a realistic assessment of the overall performance of a system to be made, subjective effects being taken into account. The use of the chart is demonstrated by examining the effects of altering certain parameters of the system. A.

612.85

5479. The anomalous behavior of the threshold of hearing in relation to the equal loudness contours. R. GUELKE AND H. HELM. *J. Acoust. Soc. Amer.*, **24**, 317–22 (*May*, 1952).

It is shown that for a 100-c/s note the well-known compression of the loudness contours at low frequencies is no longer valid near threshold. Measurements were carried out on 38 subjects in a free field test, and on 10 subjects in a monaural test to show that the intensity jump from threshold to 10 phons is greater at 100 c/s than at 1000 c/s. This is contrary to experience at higher intensities, where jump is smaller at 100 c/s than at 1000 c/s. A possible explanation for the effect is put forward involving the middle ear muscles. A.